COST REDUCTION THROUGH VALUE-ENGINEERING

INCENTIVES IN GOVERNMENT CONTRACTS

By

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CHAPTER I

INTRODUCTION

> We are obliged to assure effective and economical management of Governmental programs--both old and new. Effective management of Government activities enhances the benefits of those programs. Economical management releases resources for the people's use. . . . We will continue to offset a significant part of increased costs of important new programs by increasing efficiency throughout the Federal Government. Savings from this source have been substantial during the past year under our drive for cost reduction. I have made it clear to the heads of all Departments and Agencies that they are to continue this emphasis on cost reduction in the coming year.[1]

So spoke the President in his Budget Message to Congress on January 24, 1967. The President's statement on cost reduction reflects the recent intensified effort in the Federal Government to eliminate waste, duplication and unjustifiable expenditures of any kind. Results of the cost-reduction effort are regularly published and given wide publicity. In Fiscal Year 1966 the President reported to Congress that the Department of Defense had realized savings of $4.5 billion through its cost-reduction program and that the civilian Agencies saved $1.7 billion in the same year.[2]

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[1]U.S., President, "The President's Budget Message to Congress," Jan. 24, 1967. The Budget in Brief, Fiscal Year 1968 (Washington, D.C.: U.S. Government Printing Office, 1967), pp. 4 and 57.

[2]*Ibid.*, p. 57.

Cost-reduction programs are not new to the Federal Government. Over the years these programs have taken many forms, ranging from retrenchment and the reduction of Government activities to the development of new techniques to facilitate better and more efficient management of existing and proposed programs. The particular cost-reduction approach at any one time has usually reflected the philosophy of the current Administration and the mood of Congress.

Since World War II, a number of actions have been taken to improve efficiency and economy in the Federal Government. The recommendations of the Hoover Commissions, Executive reorganizations and Congressional actions have all contributed to significant improvements in this area.[1] These actions focused on management improvement as the most acceptable means to reduce costs. Today the retrenchment efforts of the 1920's are no longer considered the primary tool of a cost-reduction program.[2] Big Government is accepted as a necessity, and efforts are now directed primarily toward the application of new, improved, or intensified management practices to economically and efficiently manage the large and complex programs.

Of the various programs for the improvement and efficiency of operations that have been developed in the Federal Government, none have been as comprehensive or as thoroughly

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[1] U.S., Congress, House, Committee on Armed Services, Examination of Department of Defense Cost Reduction Program, 89th Cong., 2nd Sess., 1966, p. 4.

[2] Jessie Burkhead, Governmental Budgeting (New York: John Wiley and Sons, Inc., 1956), pp. 2-29.

organized as the cost-reduction program initiated by the Department of Defense in Fiscal Year 1962.[1] The Department of Defense inaugurated a program designed to reduce costs and improve efficiency in the management of equipment and supplies and other operations on a DOD-wide basis. Various existing programs, such as value engineering and incentive contracting, were integrated into the cost-reduction program to establish more uniform reporting and policy guidance. As the program has progressed, comprehensive directives have been issued regarding goals, nature of savings and detailed procedures for reporting results.[2]

This thesis examines one particular element of the DOD cost-reduction program--the use of value-engineering incentives in Government contracts. Neither value engineering nor incentive contracting are particularly new cost-reduction tools. However, only in recent years have they been used as a method to reduce procurement costs in Government contracts.

Statement of the Problem

For the Government's cost-reduction program to be effective, it must be comprehensive and must include all significant activities. Most of the in-house, cost-reduction programs can be directly controlled by Agency officials. Agency manpower levels, paperwork management and operations, and maintenance are

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[1] Examination of DOD Cost Reduction Program, loc. cit.

[2] U.S., Department of Defense, Department of Defense Cost Reduction Program--Reporting System, DOD Instruction 7720.6, January 20, 1964.

examples of the many activities in which direct cost-reduction control can be exercised. The Department of Defense's in-house, value-engineering program is an example of a cost-reduction effort in which the level of the effort can be directly controlled by Defense officials.

Significant savings can also be realized through the actions of organizations outside of the Federal Government. Government contractors, and particularly defense contractors, spend a larger portion of the Government's funds each year. In Fiscal Year 1966, the Department of Defense alone let prime contracts (for $10,000 or more) to 22,778 different companies and other organizations. These contracts totaled more than $33 billion.[1] The cost-reduction effort of these private organizations can be controlled only indirectly through the use of incentives and other contractual devices.

Since 1962, the Department of Defense has made an intensive effort to motivate defense contractors to establish affirmative programs of cost reduction. To offer real motivation to reduce costs, the incentives in contracts were expanded and refined, and competitive bidding was extended to a number of procurement actions. The incentives were designed to offer greater profits for those firms cooperating in the cost-reduction program.

Value engineering is one of the many contractual incentives offered to contractors to reduce costs. The value-engineering incentive provisions first appeared in the Armed

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[1] <u>The Wall Street Journal</u>, February 7, 1967, p. 1.

Forces Procurement Regulation in 1959. The provisions have been revised and updated several times since then in an effort to incorporate constructive suggestions from industry and to make them more effective. They have also been strengthened by providing for more liberal sharing of the savings realized through the contractors' cost-reduction programs. Theoretically, the current contractual provisions offer a vast profit potential for defense industries that actively conduct value-engineering programs.

This study examines the potential of value engineering as a management tool for effecting cost reduction in Government contracts. The study attempts to determine the extent to which contractors are realizing the full cost-reduction potential which value engineering offers. Specifically, the study attempts to answer the following questions: (1) What type of incentives are most likely to motivate industry to superior performance of contracts? (2) Considering all the pressures for satisfactory contract performance, such as meeting specifications, engineering performance and reliability requirements, and meeting shipment schedules, what relative importance does the Government and the contractor give to the contractual incentives for affirmative cost-reduction programs? (3) How great is the real potential for better products at lower cost through a comprehensive value-engineering program? (4) What profit potential is open to contractors who apply value-engineering techniques to specifications and other contractual requirements? and (5) What are the significant obstacles that reduce the effectiveness of the value-

engineering incentives in Government contracts?

The Hypothesis

The hypothesis for this study is that the current procurement regulations and implementing policy directives on the use of value-engineering incentives in contracts open many new avenues of opportunity for both industry and Government. Industry is offered a vast profit-improvement potential, and the Government is afforded the opportunity to obtain greater quantities of highly reliable goods for the funds available.

Method of Presentation

Two concepts are considered in this study. The first is cost reduction through incentive contracting, and the second is cost reduction through the use of value engineering. Although the problem centers on the integration of the two concepts, it is necessary to understand the implications of each. Chapter II is devoted to an examination of the incentives for cost reduction in Government contracts. A brief survey is made of the types and uses of various contracts. Chapter III focuses on the use of value engineering as a management tool for cost reduction. Chapter IV examines the contractual aspects of value-engineering incentives in defense contracts. This chapter will include an appraisal of industry's acceptance of the value-engineering provisions. Chapters V and VI are devoted to an appraisal of the results of value-engineering incentive contracting. Conclusions and overall recommendations are contained in Chapter VII.

Limitations

The scope of this study is limited to the activities of the Department of Defense. Other Agencies of the Federal Government also have active cost-reduction programs, and several use value-engineering incentives in their contracts. But the scope of the study is limited to the programs of the Department of Defense because it has a comprehensive contractor cost-reduction program and has pioneered the use of value-engineering incentives in Government contracts.

One objective of this thesis is to provide a convenient and concise reference for officials of all Government Agencies as well as of industry who wish to become more familiar with the use of value engineering as a cost-reduction tool, and to evaluate its advantages, limitations, and applicability to their organizations' own activities. To meet this objective, the subject material is approached from a manager's point of view. The technical aspects of value engineering and certain procedures and reports applicable only to the integrated activities of the Department of Defense are excluded or only briefly considered.

CHAPTER II

THE INCENTIVES FOR COST REDUCTION IN DEFENSE PROCUREMENTS

> I have, therefore, instructed the Secretary of Defense to reappraise our entire Defense strategy--our ability to fulfill our commitments--the effectiveness, vulnerability, and dispersal of our strategic bases, forces, and warning systems--the efficiency and economy of our operation and organization--the elimination of obsolete bases and installations--and the adequacy, modernization and mobility of our present conventional and nuclear forces and weapons systems in the light of present and future dangers.[1]

President John F. Kennedy, in his first State of the Union Message, set the standard by which the activities of the Department of Defense, and indeed the whole Federal Government, were to be measured during his Administration. To meet the challenge offered by the President, many new and far-reaching policies and programs have been established in the Department of Defense. The formal establishment of a Cost-Reduction Program was one of the actions taken to carry out the President's mandate.

The DOD Cost-Reduction Program covers all aspects of the Department's activities, and has taken many forms, from the closing of bases to administrative reorganizations. This chapter examines one element of the program--cost reduction in defense procurements. It is examined within the context of the

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[1]U.S., President, "Annual Message to Congress on the State of the Union," Public Papers of the Presidents--John F. Kennedy, 1961, (Washington, D.C.: U.S. Government Printing Office, 1962), p. 23.

overall cost-reduction environment. The cost-reduction potential of various types of contracts will be considered. To form a basis for discussing the use of value-engineering incentives, a close examination will be made of incentive contracting.

The DOD Cost-Reduction Program

The DOD Cost-Reduction Program was introduced July 5, 1962.[1] On that date the Secretary of Defense, the Honorable Robert S. McNamara, reported to the President that the program would be centered around three basic concepts: (1) buying only what is needed, (2) buying at the lowest sound price, and (3) reducing operating costs. He announced that the ultimate goal of the Cost-Reduction Program was to realize a savings of at least $3 billion per year by Fiscal Year 1967.[2]

Since 1962, a number of programs and policies have been formulated to foster this environment of cost effectiveness and cost reduction. These include such techniques as the Planning-Programming-Budgeting System (PPBS), integrated logistic support, incentive contracting, the use of the weighted guideline method for determining negotiated profit objectives, total-package and multi-year procurements, and an intensive in-house, value-engineering program. These techniques have produced impressive results.

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[1] U.S., Department of Defense, DOD Cost Reduction Program, July 5, 1962, (Washington, D.C.: U.S. Government Printing Office, 1962), p. 2.

[2] Ibid., pp. 2-3.

In July 1966, the Secretary reported to the President that the DOD had far exceeded the original cost-reduction goals announced in July, 1962.[1] As indicated in Figure 1, savings of $4.5 billion were realized in Fiscal Year 1966.[2] The Secretary also reported to the President that a new savings goal of $6.1 billion a year by Fiscal Year 1969 had been established.

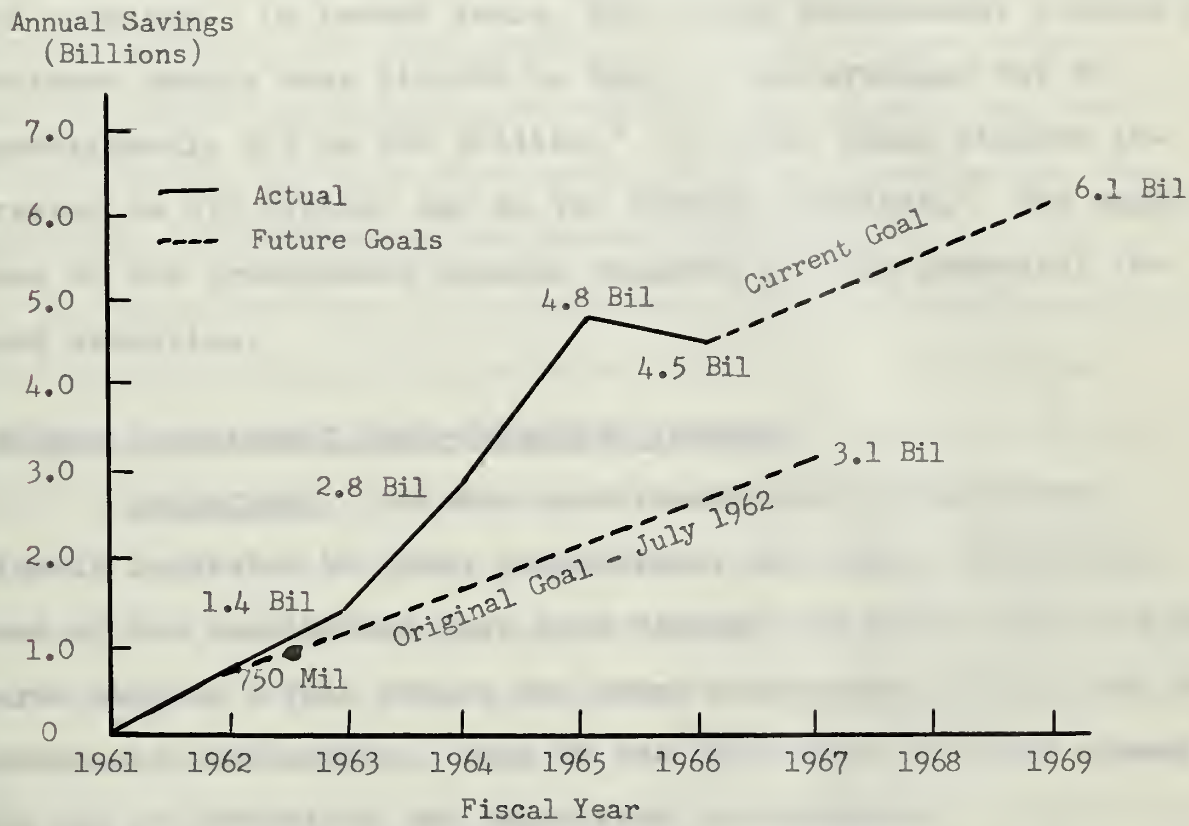

Fig. 1--Progress of DOD Cost-Reduction Program

Much of the success of the Cost-Reduction Program can be attributed to the support and positive influence of the top Defense officials. Also integral to the success of the program is

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[1]U.S., Department of Defense, DOD Cost Reduction Report, July 5, 1962, (Washington, D.C.: U.S. Government Printing Office, 1966), p. 1.

[2]DOD Cost Reduction Report, July 8, 1966, op. cit., p. 2.

the use of cost-reduction techniques in all sections of the defense establishment. In the area of procurements from the private sector of the economy, the need for positive cost-reduction programs is especially important.

A significant portion of the annual DOD budget is paid out to private contractors through contracts for necessary goods and services. In recent years, the annual procurement program of contract awards over $10,000 by the DOD has averaged out to approximately $25 to $26 billion.[1] In 1966, these figures increased to $33 billion due to the Vietnam conflict.[2] The magnitude of the procurement program suggests a large potential for cost reduction.

Defense Procurement Cost-Reduction Program

Background. Defense procurements have always been closely regulated by laws, regulations, and policy directives. Most of the regulations have been designed to ensure that the taxpayer obtains a fair return for every procurement dollar paid to Government contractors. Most of the early laws centered around the use of advertised and negotiated procurements.

Prior to World War II, advertised bidding was the primary means of selecting a contractor. The first Federal statute requiring advertised bidding was enacted in 1809.[3] In 1860, a

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[1] U.S., Department of Defense, Incentive Contracting Guide, (Washington, D.C.: U.S. Government Printing Office, 1965), p. 2.

[2] The Wall Street Journal, February 9, 1966, p. 1.

[3] U.S., 2 Statutes 536 (1809).

landmark statute was enacted which required all purchases to be advertised in advance, except for personal services and instances where the public exigency would not permit the delay incident to advertising.[1] This 1860 law regulated military procurements until World War II.[2]

Just prior to World War II, Congress began to realize that the rigid requirements for advertised bidding were not suitable for all types of procurements. A number of laws were enacted to permit negotiated procurements. The First World Powers Act of 1941 was the last of a series of prewar procurement acts, relaxing the requirements for advertised bidding.[3]

After World War II, a Navy committee was established for the purpose of developing peacetime procurement regulations. From this study evolved the Armed Services Procurement Act of 1947.[4] From this Act the Department of Defense wrote the Armed Services Procurement Regulation in 1956. The Act required the return to advertised bidding as the normal procurement practice. However, it specified 17 circumstances in which negotiated procurements would be appropriate.[5]

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[1] U.S., Department of the Navy, Navy Contract Law, 2nd ed., (Washington, D.C.: U.S. Government Printing Office, 1959), p. 112.

[2] Ibid. [3] U.S., 55 Statutes 839 (1941).

[4] U.S., 10 United States Code 137.

[5] U.S., Department of Defense, Armed Services Procurement Regulation, Section 3, Part 2, (Washington, D.C.: U.S. Government Printing Office), (hereinafter referred to as ASPR).

The above-enumerated laws, plus many other laws, Congressional inquiries and investigations, have been prompted in part by reports of excessive profits from Government contracts. Undoubtedly there have been some instances in which these reports have had substance. Such charges of abuse are outside the scope of this study. The point is that these charges have brought about tighter regulatory control, particularly in the area of profit levels.

One of the major actions to eliminate excessive profits from contracts was the establishment of the Renegotiation Board in 1951.[1] The Board is an independent Agency. It annually reviews the aggregate profits earned by defense contractors under certain Government contracts. It determines what profits are excessive and orders them refunded to the Government. Decisions of the Board may be appealed to the United States Tax Court.

Critics of the profits earned by Government contractors too often overlook the purpose of profits and the benefits that the Government may realize by maintaining them at a satisfactory level. A contractor must be offered motivation to accept certain risks inherent in Government contracts, to perform economically and efficiently, to provide high quality products, and to take affirmative action to reduce or eliminate unnecessary costs. One of the key factors which motivates a contractor to perform all these things is the anticipation of profit--profit on the current contract and on future contracts.

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[1]U.S., 50 United States Code, Sections 1211-1233.

The Profit Motive. A profit-making organization may, and usually does, have multiple objectives. Many authorities on organizational management believe that the designation of profit as the supreme objective is a gross oversimplification of the problem.[1] But in the long run, a company must earn a satisfactory level of profit and return on its investment if it is to remain in business. Therefore, when the Government does business with a profit-making organization, a most effective incentive for efficient performance is the appeal to the profit motive.

By increasing the use of competitive procurement and incentive contracting, the Government has acknowledged that the profit motive offers an excellent means to induce contractors to perform their contracts efficiently. The Government has also recognized that profit makes up only a small percentage of the total cost of defense procurements, and that any real reduction in procurement costs can only be achieved in the cost area.[2] Defense procurement policies are designed to offer greater profits and rewards to contractors who hold down procurement costs and less profit to those who perform contracts inefficiently. The Defense Contractor Cost-Reduction Program is based primarily on the greater use of competitive procurement and incentive contracts.

Competitive Procurement. Competition and the "free enterprise" way of doing business is a cornerstone of our

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[1] W.H. Newman and C.E. Summer, Jr., The Process of Management, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1961), pp. 383-385.

[2] Ralph C. Nash, Incentive Contracting, (Washington, D.C.: The George Washington University, 1963), p. 2.

American heritage. Companies compete for a share of the market by developing new or better products at lower costs. The customer is rewarded with greater value, and the company realizes greater profits through increased business. Maximum competition in procurement represents sound business policy. It is one of the most effective means for the Department of Defense to broaden the industrial base and ensure that the lowest sound price is obtained.

Industry has three means to increase profits. It can raise prices, lower production cost, or increase the volume of profitable activities. A competitive climate virtually eliminates significant price rises; in fact, the trend is toward lower prices. The volume of business depends upon the number of successful bids at low prices. Thus, in a competitive market, the only real avenue available to increase profits is to lower production costs.

Value engineering is one of the best techniques available to industry to lower costs. As will be shown later, many companies which successfully compete for contracts on a competitive basis, also realize attractive profits by lowering production costs through the use of value-engineering techniques.

In defense contracts, experience has shown that, on an average, at least 25 cents is saved on each dollar shift from noncompetitive to competitive procurement.[1] Because of this, the trend toward noncompetitive procurement was reversed in 1961. Directives were issued requiring price competition wherever

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[1] <u>DOD Cost Reduction Report</u>, July 8, 1966, <u>op. cit</u>., p. 12.

practicable, with sole-source procurement to be allowed only after rigid review.[1] As indicated in Figure 2, contracts awarded on a competitive basis have risen from 32.9 per cent in Fiscal Year 1961 to over 46 per cent in Fiscal Year 1966.[2] This shift has resulted in an estimated savings of $605 million in Fiscal Year 1966.

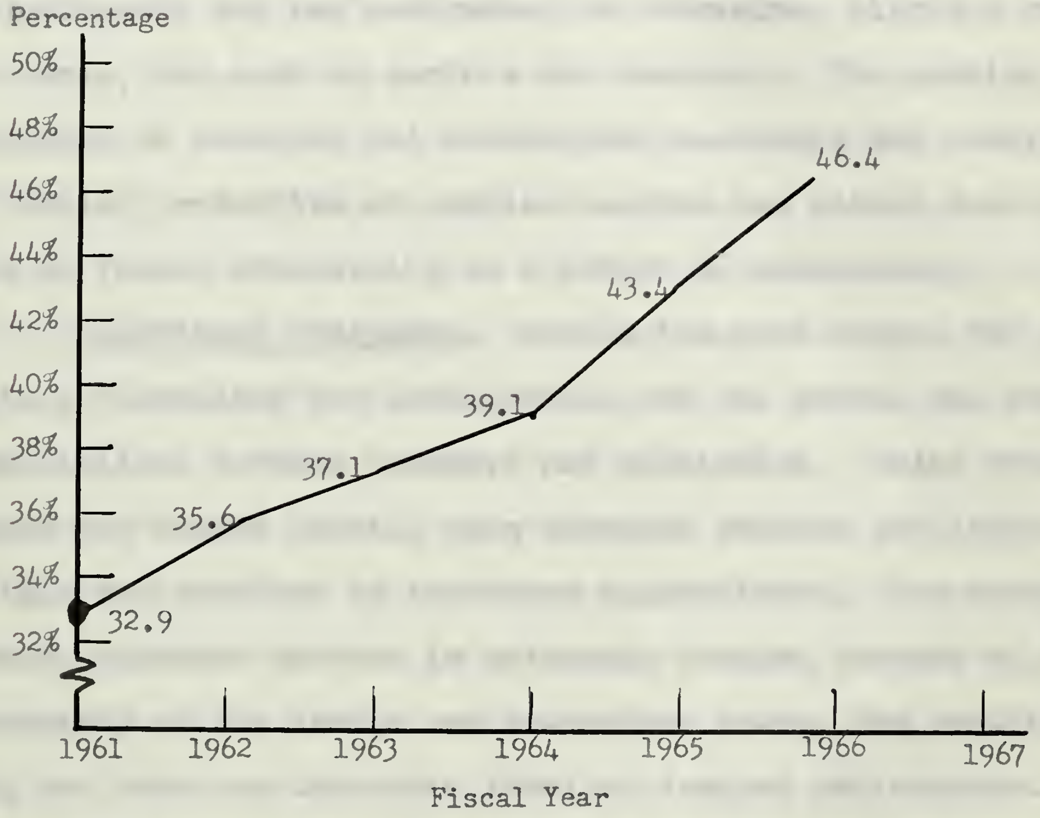

Fig. 2--Contracts Awarded on Basis of Competition as a Per Cent of Total Dollar Value of Contract Awards.

Advertised Procurement. In most routine procurements, the advantages of competition can best be obtained through formal advertising. Under this method, the terms and conditions of the

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[1] DOD Cost Reduction Report, July 5, 1962, op. cit., p. 4.

[2] DOD Cost Reduction Report, July 8, 1966, op. cit., p. 12.

contract are set forth and qualified vendors are invited to make bids. Sealed bids are submitted by interested parties. These bids are publicly opened at a specified time and the contract is awarded to the responsible bidder whose bid is most advantageous to the Government, considering price and other factors.[1]

The effectiveness of formal advertising is dependent upon an adequate number of qualified bidders and a reliable means for the Government and the contractor to determine, within a reasonable range, the cost to perform the contract. The growing preponderance of research and development contracts and contracts for limited production of complex weapons has placed some limitations on formal advertising as a method of procurement.

Negotiated Contracts. During the past decade the pace of military technology has accelerated, and the number and complexity of specialized defense products has multiplied. Major weapons systems now depend heavily upon advanced science and technology, and this has resulted in increased expenditures. The procurement of these advanced systems is extremely complex because of the uncertainty of the design and production costs, the required lead time, and even the uncertain level of desired performance. In such an atmosphere of uncertainty and risk, the use of competitive procurement breaks down. Hitch and McKean sum up the problem this way:

> When goods and services are purchased by government agencies on the basis of full and free competitive bidding, there is a presumption that competitive forces, working through the price and market mechanism, will provide the same spur to efficiency and low-cost supply that they do elsewhere

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[1]ASPR, Section II, Part 2.

[illegible]

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in the private economy. But only a rather minor portion of Service purchases are made, or can be made, on the basis of competitive bidding. The expensive items of major equipment like aircraft, submarines, and tanks and their expensive major components can be produced by very few companies, and their production costs are seldom accurately estimated in advance. Moreover, frequent and extensive modifications of the original design are the rule rather than the exception both in development and in production. In these circumstances "negotiated" contracts and the "cost-plus" type are widely used.[1]

Many of the defense procurements are of such magnitude and complexity that only a few select companies are capable of bidding on them. These large procurements are characterized by a unique set of uncertainties such that even the select few industrial giants are unwilling to assume the risk on bidding for the contract on a firm-fixed-price basis. Under the fixed-price contract, where uncertainties regarding cost are extreme, the actual price established through competitive bidding may be far off the mark. In such a case, if the bid is far too low, a single large contract can force a major company into bankruptcy. Through negotiations, the Government and the potential contractors are free to discuss and bargain on many aspects of the planned procurement. Much of the negotiating centers around the amount of price risk the contractor will assume under the contract.

A negotiated procurement has the same objective as an advertised procurement--the best possible terms for the Government. Negotiated procurements do not preclude competition. Several potential contractors may submit proposals to serve as a basis for negotiations. Unlike formal advertising, however,

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[1]Charles J. Hitch and Ronald N. McKean, The Economics of Defense in the Nuclear Age, (New York: Atheneum, 1960), p. 230.

negotiated procurements are not solely dependent upon the interaction of competitive forces. This lack of full competition lowers the incentive to hold costs down. To compensate for this reduced competitive incentive, other types of cost-reduction incentives are required in negotiated contracts.

Types of Contracts

Government contracts can be grouped into two main categories. These are fixed-price contracts and cost-reimbursement contracts.

Fixed-Price Contracts. As a class, fixed-price contracts are more desirable than cost-reimbursement contracts. Fixed-price contracts are characterized as follows: (1) A maximum price ceiling is set. (2) The contractor assumes the maximum risk. (3) Fewer administrative problems are involved. (4) They are generally written when specific and detailed items can be made available. And (5) pricing can be fairly well established.

There are four main types of fixed-price contracts. They are: (1) Firm, (2) Redeterminable, (3) Escalation, and (4) Incentive. The Government considers the Firm-Fixed-Price (FFP) contract to be the most desirable and encourages its use whenever circumstances permit. Under the FFP contract, the contractor assumes all the risks and responsibilities. His profit depends upon his ability to reduce costs. For this reason the FFP contract gives the contractor the maximum incentive to avoid waste and to use such cost-reduction techniques as value engineering.

The Fixed-Price with Provision-for-Escalation contract generally provides for a price modification when a change occurs

in the cost of labor or material. The change is normally based on a recognized price index. A Fixed-Price with Provision-for-Redetermination contract provides a means for shifting some risk to the Government, thus avoiding contingency fees in a FFP contract. The final price is determined at various steps during the contract or after the contract. The Fixed-Price-Incentive (FPI) type contract will be examined later under incentive contracting.

Cost-Reimbursement Contracts. The cost-reimbursement-type contracts are normally used when a fair contract price cannot be established. The Government pays all allowable contract costs. There are four major cost-reimbursement contracts. They are: (1) Straight-Cost, (2) Cost-Sharing, (3) Cost-Plus-Fixed-Fee, and (4) Cost-Plus-Incentive-Fee.

Under the Straight-Cost-type contract, all allowable costs are reimbursed, but the contractor receives no fee. The Cost-Sharing contract also provides for no fee. In addition, the contractor shares the contract costs with the Government according to an established formula. The Straight-Cost and Cost-Sharing contracts are normally used in cases where the contractor receives some commercial benefit as a result of the work performed under the contracts.

Under the Cost-Plus-Fixed-Fee contract (CPFF), the Government agrees to bear all the costs incident to the contract and, in addition, pays the contractor a fixed fee for his effort. This type of contract has several advantages. It permits the work to get underway rapidly, with no lengthy preliminary

negotiations, and it is particularly suited for highly uncertain situations.

The CPFF contract also has several distinct disadvantages. First, experience has shown that there is little competition when such contracts are negotiated.[1] Second, there is little incentive to produce efficiently when all allowable costs are reimbursed and the fee is fixed in advance. Because of these disadvantages, a major goal of the DOD Cost-Reduction Program is to reduce the number of CPFF contracts. Currently the proportion of CPFF contracts awarded have reached a rate of 8.9 per cent with the peak of 38 per cent recorded in March, 1961.[2]

The last type of cost-reimbursement-type contract, the Cost-Plus-Incentive-Fee, will be examined below.

Incentive Contracts. Incentive contracts offer the most attractive alternative when the use of FFP contracts is impossible or inappropriate. The essence of the incentive contract is that it offers a contractor more profit if he reduces costs or improves performance, and less profit if costs increase or performance goals are not met.[3] Since 1961, a goal of the DOD Cost-Reduction Program has been to use incentive contracts in instances where FFP contracts are not applicable.

Incentive-type contracts are designed to motivate improved contractor performance in the areas of cost, performance, and delivery. The contractor cannot improve profits by reducing

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[1] Hitch and McKean, op. cit., p. 231.

[2] DOD Cost Reduction Report, July 8, 1966, op. cit., p. 14.

[3] Nash, op. cit., p. 1.

costs at the expense of performance. Rather, he must find ways to provide equal or better products at lower costs if he is to realize the maximum benefits under incentive contracts. Value engineering, as will be demonstrated, is a powerful tool for achieving that objective.

In essence, nearly all incentives in Government contracts take the form of sharing arrangements.[1] Their common feature is that the contractor is permitted to keep a part of any cost savings, relative to some "target" cost named in the contract, and he is penalized by some part of any costs in excess of the target. The target cost represents the best mutually determined estimate of what the contract cost will actually be. The target cost should represent that figure at which there is equal probability of either a cost overrun or underrun. The achievement of a good target cost is not an easy process, but with the development and use of such techniques as PERT and its extension, PERT/COST, this task is becoming increasingly manageable.[2]

The sharing arrangements under incentive contracts are normally expressed as a percentage ratio. For example, if a 50/50 sharing arrangement is negotiated, the Government and the contractor will share equally all the costs incurred in excess of the negotiated target cost. Conversely, the Government and the contractor will be sharing equally, all savings realized if the actual cost of the contract is below the negotiated target cost. The profit or fee is thus tuned to the contractor's ability to

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[1]Nash, op. cit., pp. 4-5.

[2]Incentive Contracting Guide, op. cit., p. 13.

hold down costs.

The two basic types of incentive contracts are the Fixed-Price-Incentive Contract (FPI)[1] and the Cost-Plus-Incentive-Fee Contract (CPIF).[2] Both appeal to the profit motive by increasing or decreasing the contractor's profit or fee, on the basis of some predetermined formula, as his actual costs fall above or below the contract target cost.

The FPI contract contains a target cost, a target profit, a ceiling price and a sharing formula. After the work is completed, the contractor and the Government negotiate the final costs of the contract, sharing the overruns and underruns according to the agreed-upon formula. Regardless of the final cost to the contractor, he must meet the contractual specifications, and the Government's liability cannot exceed the predetermined ceiling price. For this reason the Government prefers this type of contract to any other cost-reimbursement-type contract whenever circumstances permit.[3]

The CPIF-type contract differs from the FPI contract in that it has no fixed ceiling price, has a range of cost sharing limited by the maximum and minimum fee, and is settled by vouchering all costs.[4] CPIF contracts are normally employed where there is not a high degree of confidence in the cost estimate. The sharing formula employed in CPIF contracts vary greatly according to the degree of confidence in the cost estimate.

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[1]ASPR, 3-404.4. [2]*Ibid.*, 3-405.4.

[3]*Incentive Contracting Guide*, *op. cit.*, p. 5.

[4]Nash, *op. cit.*, p. 8.

Response to Incentives

There is substantial evidence that the cost-reduction efforts of the Defense Department are accepted, if not welcomed, as a necessary part of doing business with the Government. As one industry official put it:

> If you're interested in your paycheck, then you have to be interested in cost reduction and cost avoidance too. For it has become clearly evident that each and every defense company will have to emphasize thrift and frugality more than ever before and devise new ways to give the customer a dollar's value for every dollar spent.[1]

Historically, one of the sharpest thorns pricking industry has been overmanagement in contracting. The new techniques employed to reduce costs in defense contracts places greater, not lesser, constraints on industry. Realizing this, DOD has attempted to compensate with higher profits. Some industry executives, however, contend that regulations extend far beyond profits. Mr. Harry Benoit, Jr., Manager of the Government Contracts Department of Barnes Engineering Company states that despite many allegations to the contrary, Government contracts are not lucrative from a profit viewpoint, yet the rigid regulations entail many problems and unnecessarily curtail management prerogative.[2] Hitch and McKean rebut this often-heard allegation of excessive regulations as follows:

> The relaxation of contractual constraints, while highly desirable in itself, depends upon the development of satisfactory substitutes for "cost-plus." Rightly or wrongly (we

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[1]Howard E. Lee, "What We've Done About Reducing Cost," Armed Forces Management, Dec., 1964, p. 47.

[2]Harry Benoit, Jr., "Can We Have Government Contracts and Free Enterprise?," Financial Executive, Sept., 1963, p. 39.

> think rightly), the Congress and the public are determined that contractors be kept from cheating on cost-plus, even to the point of being willing to sacrifice some efficiency to prevent fraud (or just excessive pocket-lining). An adequate incentive plan or adequate competition would be far more effective in preventing abuses than rules and contracting officers. . ., but until we develop such a substitute we are stuck with the rules.[1]

All contractors are encouraged to intensify their efforts to realize cost reduction in the performance of defense contracts. For those contractors having an overall annual volume of defense sales in excess of $5 billion, exclusive of Firm-Fixed-Price contracts, a special contractor cost-reduction program has been established.[2] Contractors who accept the invitation to report their accomplishments under this program submit their cost-reduction results to the DOD twice yearly for evaluation.[3] Their accomplishments are widely publicized and are considered in making future source selections and in determining profit and fee rates in noncompetitive negotiated contracts. By Fiscal Year 1966, seventy-five firms had volunteered to participate in the special program.[4]

In September, 1966, a special committee of Congress issued a report that was highly critical of the DOD Cost-

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[1]Hitch & McKean, op. cit., p. 233.

[2]U.S., Department of Defense, Defense Contractor Cost Reduction Program, DOD Instruction 7720.12, January 18, 1965, Section IV-C.

[3]Ibid., IV-E.

[4]U.S., Department of Defense, Cost Reduction Actions By Defense Contractors, May 1966, (Washington, D.C.: U.S. Government Printing Office, 1966), p. vii.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Reduction Program.[1] The report questioned the validity of many of the claimed savings. The report concurred with DOD in the need for a cost-reduction program, but then went on to state:

> The sprinkling of a few true savings actions in a pot containing many which are either invalid or questionable does not turn the mixture into pure gold. Instead, the debased result could make the whole program suspect, causing it to lose its value and force as a powerful aid to real economy.[2]

The committee examined a number of cases of claimed savings under the Cost-Reduction Program. It uncovered some instances where true savings were questionable or where documentation failed to support the claimed savings. In other instances the committee reported that savings were realized at the expense of degraded military capability.[3]

Dr. Daniel Borth, of the General Accounting Office takes a slightly different approach to the Cost-Reduction Program.[4] He suggests that cost reduction and motivation must be tied together. A cost-reduction program provides a vehicle to formally acknowledge action taken to reduce costs and improve efficiency. It costs the Government very little to be generous in its praise and rewards for cost-reduction efforts by organizations and individuals. Some efforts may result in questionable true savings or may be difficult to document. But in terms of morale and motivation, it is better to give too much rather than too little credit. In the long run, a continuing cost-reduction effort will

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[1] Examination of DOD Cost Reduction Program, op. cit.

[2] Ibid., p. 3   [3] Ibid., pp. 27-40.

[4] Personal interview with Dr. Daniel Borth, Associate Director, Management Control Systems, Defense Division, U.S. General Accounting Office, Jan. 31, 1967.

produce substantial true savings. For this reason, it may not be fair to judge the value of the program by examining isolated questionable cases.

Summary and Conclusions

Since 1961, the Department of Defense has initiated far-reaching programs in the area of cost reduction. The DOD has reported substantial dollar savings from these programs. Despite its critics, there is every indication that the cost-reduction effort will be intensified and broadened in future years.

Cost reduction in defense procurements is a major element of the total DOD program. The renewed emphasis on competitive procurements and the increased use of Firm-Fixed-Price and Incentive-type contracts has resulted in significant savings.

This thesis questions what types of incentives are most likely to motivate industry to superior performance. The evidence in this chapter supports a tentative broad answer. The incentives must be keyed to the profit motive, must be real, not token, and must be administered consistently. Also questioned by this thesis is the importance of cost reduction to the Government relative to the numerous other contract considerations such as performance and quality requirements and delivery schedules. The evidence is clear that cost reduction is not secondary to any contract requirements. Conversely, a contractor is expected to provide increasingly superior products within specified time periods--all at lower overall costs.

In conclusion, it may be stated that a most favorable cost-reduction climate has been created in the Department of

Defense. This climate fosters the use of all effective cost-reduction tools. The study will now shift to an examination of one of these tools--the use of value-engineering incentives in defense procurements.

CHAPTER III

PRINCIPLES OF VALUE ENGINEERING

Introduction

The value of the cost-reduction incentives offered to the contractor is ultimately measured in terms of the results of the contractor's cost-reduction efforts. A contractor may be highly motivated, but if he is unable to apply the appropriate cost-reduction techniques, he will have poor results. Value engineering is one of the better cost-reduction tools available to the defense contractor.

Value engineering, or value analysis as it is often called, is a unique cost-reduction method which was developed and perfected in the late 1940's by Lawrence D. Miles of the General Electric Company.[1] It was developed in response to the need for more cost consciousness in the design, development, production and maintenance of complex equipment. As the ever increasing pace of technological advances in the 1950's and 1960's focused more attention on this need, value engineering gained wide acceptance by industrial firms, both large and small. It has been the subject of numerous articles, conferences, and symposia, and more recently it has been offered as a formal academic course

[1]Lamar Lee, Jr., and Donald W. Dobler, Purchasing and Materials Management, (New York: McGraw-Hill Book Co., 1965), p. 218.

by a number of universities.[1]

The Department of Defense's interest in value engineering results from an awareness of its potential contribution toward cost effectiveness in the acquisition of defense materials.[2] From an economic point of view, there is only a limited amount of resources available for defense materials. This limitation requires the use of resources in such a manner as to maximize output.[3] Value engineering, from the economic standpoint, contributes to the efficiency with which allocated resources are used. It can help make it possible to obtain maximum defense for a given amount of resources.

A clear understanding of value engineering is essential if it is to achieve its potential as a significant cost-reduction tool in defense procurement. A knowledge of what constitutes value in defense products and how value engineering affects product value is essential. This chapter is devoted to a discussion of the concepts and techniques of value engineering and its practical application and use in industry and Government.

Value Engineering Defined

Because of its many applications, a number of definitions have been used to describe value engineering. Basically, value

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[1]Personal interview with Mr. Rudy Kempter, Value Engineering Division, Office of the Deputy Assistant Secretary of Defense (I&L), Jan. 12, 1967, (hereinafter referred to as Kempter Interview).

[2]U.S., Department of Defense, Value Engineering Handbook, (H-111), March 29, 1963, (Washington, D.C.: U.S. Government Printing Office, 1963), p. 1.

[3]Hitch and McKean, op. cit., pp. 23-43.

engineering is concerned with the elimination or modification of anything that contributes to the cost of an item but is not necessary to required performance, quality, maintainability, reliability, standardization or interchangeability. Lawrence D. Miles defines value engineering this way:

> Value analysis [Value engineering] is a philosophy implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills. It is an organized creative approach which has for its purpose the efficient identification of unnecessary cost, i.e., cost which provides neither quality nor use nor life nor appearance nor customer features.[1]

This rather high-powered definition has been reworded into the context of DOD activities. The Department of Defense defines it as follows:

> Value engineering is an organized effort directed at analyzing the function of defense hardware with the purpose of achieving the required function at the lowest cost.[2]

Value engineering focuses on one objective--equivalent performance at lower costs. This differentiates it from the traditional methods of cost reduction which offer trade-offs between performance and cost. Value engineering does not look for cost performance trade-offs. Rather it looks for ways to improve quality and reliability at lower costs. The key words in DOD's definition of value engineering are value, function and organized approach.

Value. To fully understand value engineering, it is necessary to consider what constitutes value in products. The

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[1] L.D. Miles, Techniques of Value Analysis and Engineering, (New York: McGraw-Hill Book Co., 1961), p. 1.

[2] Value Engineering Handbook, op. cit., p. 2.

word value has many meanings to different people. The dictionary dwells at considerable length on the many meanings of value. Within the context of value engineering, value refers to relative worth, utility or importance.[1]

Although value is a broad term, it has been categorized so that it can be defined meaningfully. Four such categories are:

Use Value:	Based on the properties and qualities of a product or material which accomplish a use, work or service.
Cost Value:	Based on the cost of a product, almost always expressed in money.
Esteem Value:	Based on the properties, features or attractiveness involved in pride of ownership of the product.
Exchange Value:	Based on the properties or qualities which make the product exchangeable for something else.[2]

The real value of a product probably embodies all of the preceding factors and more. For each product, the importance of the different categories of value varies from person to person, from customer to producer. An automobile dealer views the automobile in terms of its exchange value. The potential customer views the same vehicle in terms of its use value versus cost value, esteem value, and trade-in or exchange value.

For the vast majority of defense hardware, use value and cost value are virtually the only factors of significance.[3]

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[1] Webster's New Collegiate Dictionary, (Springfield, Mass.: G. & C. Merriam Co., 1953), p. 940.

[2] Value Engineering Handbook, op. cit., p. 1.

[3] Ibid.

Esteem and exchange values are negligible compared to use value. Fortunately, use and cost value can be stated in terms of operating requirements of functional characteristics, and cost value can be stated in terms of dollars.

In the Department of Defense, the value-engineering approach to products is that use value should equal or exceed the cost value. The value of the end product approaches its maximum if its cost is made up solely of features which contribute to its use and do not include any factors which contribute cost toward esteem or exchange. A value-engineering goal is the maximization of end-product value through the control of use value and cost value and the costs associated with any other value.[1]

Secretary McNamara stated his case for the elimination of costly esteem and exchange value in defense products this way:

> There is no point in paying for performance or quality features that are not needed to accomplish the essential task. In a meaningful sense, procurement of excessive performance or quality . . . is just as wasteful as procurement of excessive quantities.[2]

Mr. McNamara characterizes defense products with excessive quality and value characteristics as "goldplated." The elimination of goldplating in defense products is a major goal of the DOD Cost-Reduction Program.[3]

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[1] U.S., Department of Defense, Principles and Applications of Value Engineering, (Washington, D.C.: Office of Assistant Secretary of Defense (I&L)), pp. 1-3.

[2] R.S. McNamara, "Statement Before the Subcommittee on Defense Procurement, March 28, 1963." An Introduction to Value Engineering, (Redstone Arsenal, Alabama: U.S. Army Missile Command), p. 3.

[3] DOD Cost Reduction Report, July 8, 1966, op. cit., p. 9.

Although cost and use value can be stated precisely, value is always relative, not absolute. High value is a function of both use and cost values and the relation between them. For example, an item with only an average use value, but below average cost value, may have higher value than one which is above average in use value but is obtainable only at a very high cost. Such relationships are also the basis for the systems-analysis techniques and cost-effectiveness studies which have been introduced in the DOD.[1]

Function. The value of a product is measured in terms of its function. Value-engineering studies focus on the function which the product performs rather than on the product itself. They take nothing for granted and attack everything about the product, including the item itself, subject only to the restriction that the required function must not be changed. In other words, they look at functional value rather than product value. The studies seek minimum cost by considering the various methods of achieving the required function rather than by considering ways of reducing cost of a specific method. Only after the function of the product is considered, is the product itself evaluated. The consideration of the function is the fundamental skeletal structure of the value-engineering method.[2]

Function describes the purpose or objective of a product. In simple terms, functional requirements are those explicit

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[1]Charles J. Hitch, Decision Making for Defense, (Berkeley, Calif.: University of Calif. Press, 1965), pp. 43-58.

[2]Principles and Applications of Value Engineering, op. cit., pp. 1-4.

performance characteristics that must be possessed by the hardware if it is "to work." They define the limits of what the hardware must be able to do in relation to the larger system of which it is a part.

In attempting to define the function of a product, it is helpful to describe it in the form of two words, a verb and a noun.[1] For instance, the function of a light bulb is to "provide light." In addition to the primary function, products also have one or more secondary functions. For instance, a light bulb may be required to withstand severe environmental conditions. It is important that the value engineer carefully identify all required functions, whether they are primary or secondary.

The Job Plan. The systematic or organized approach to value engineering requires the development of a job plan. Such a formal plan is instrumental in achieving best results from value-engineering studies.

*Because value is relative, comparison is essential in evaluating the functions of a product. The value-engineering approach requires answers to the following five questions:

What is the item?

What does it cost?

What does it do?

What else will do the job?

What will that cost?[2]

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[1]Miles, op. cit., p. 14.

[2]Arnold Curtin, "Value Analysis: Management's Cost Control Mainstay," The Journal of Accountancy, October, 1966, p. 56.

The purpose of these questions is to uncover needed pertinent facts. The answers to these questions serve as the basis for developing objective data for decision-making. By applying the answers to the primary and secondary functions of a product, unnecessary product costs will be identified, alternative methods will be discovered which will accomplish the function, and the cost of alternatives will be available for comparison.

The value-engineering job plan was developed by Lawrence D. Miles.[1] Many versions of the plan have been adapted by the Government and industry to meet a variety of needs. Presupposing that an item has been selected for study, the phases of a typical job plan might proceed in the following manner:[2]

<u>Information Phase</u>. The first phase of the job plan is to gather facts, analyze the function which the product performs and establish criteria against which possible improvements can be made.

<u>Speculative Phase</u>. In this phase, alternatives are developed which offer potential solutions to the value problem.

<u>Evaluation Phase</u>. In this step of the value-engineering process, the various alternatives which have been developed are subjected to a test of their economic feasibility. Each alternative is costed, with the goal of ranking the feasible solutions according to their cost. The cost considered must include the unit costs, implementation costs, estimating the number of units to which the change will apply as well as the cost of supporting and maintaining the alternative method.

<u>Testing and Verification Phase</u>. At this point all the economically feasible solutions are tested to ensure that they will provide the required function.

<u>Implementation and Follow-up Phase</u>. The proposal is now written up and submitted to management for adoption.

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[1]Miles, <u>op. cit</u>., p. 24.

[2]This job plan was adapted from the plan suggested by Mr. Miles.

Once the proposal is submitted, it must be followed up periodically in order to monitor its progress.

The formal use of a job plan assures that all elements of value engineering are given comprehensive consideration.

Of all the phases within the job plan, the development of alternatives which can accomplish the required function is perhaps the most difficult step. The search for alternatives is a highly creative process. It requires the generation of new and "bright" ideas. Old conventions and mental attitudes which tend to inhibit creative thinking must be eliminated. Since much has been written on the creative process, it will not be discussed in this paper.[1] It is sufficient to note that value engineering requires real imagination and creativity, particularly in the selection of alternatives.

Application

Value engineering is concerned mostly with hardware and end-item products. It may be applied to hardware during its conception, development, engineering or production stages. It is also used on a wide variety of nonhardware products. Some examples are: (1) preparation of technical manuals, specifications, and drawings, (2) establishment of requirements for data, and (3) report preparation.[2] This paper centers its discussion of value engineering on its application to hardware, and particularly defense hardware.

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[1] An excellent discussion on the creative process is contained in Newman and Summer, <u>The Process of Management</u>, <u>op. cit.</u>, pp. 276-296.

[2] Miles, <u>op. cit.</u>, p. 43.

Although value engineering is applicable at any point in the life cycle of the product involved, and on a wide range of products, practical considerations dictate that it be limited to those products and phases of products where there is a high potential for cost reduction. In any organization the resources that can be allotted to a value-engineering program are limited. To realize the full potential of the program, the value-engineering team needs a criteria to decide when and where value engineering should be applied. One Army command pictures the problem this way:

> A poor choice of the object of a value-engineering study will produce small savings no matter how well the study is accomplished. Because manpower resources limit the number of possible value-engineering studies over a period of time, it is mandatory the studies be conducted in areas where the greatest gains will be realized.[1]

There are no hard and fast rules as to where or when the application of value-engineering techniques will result in significant cost savings. As a general rule, however, substantial savings should result when applied to products in the following instances: (1) products purchased in large quantities, (2) products where design is pushing the state of the art, (3) highly complex products, (4) products which have had accelerated development programs, and (5) high-cost products.[2]

The earlier value engineering is applied in the life cycle of a product, the greater the potential savings. Early

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[1]U.S., Department of the Army, Criteria For Selection of Value Analysis/Engineering Products, (Washington, D.C.: Headquarters, Army Material Command, 1964), p. 13.

[2]Ibid.

application means that there are more units of production to which cost-reduction changes will be applied. Also, the earlier the change, especially if it can be made before production begins, the lower the implementing costs will be from the standpoint of modifications to production lines, tooling, procedures, etc., and changes to logistics and support elements such as spares and maintenance manuals.[1] The advantages of early value engineering are illustrated in Figure 3. This graph is based on the experience with value engineering in the Department of the Army.[2]

While early application is desirable, it is not always practical. In the design stage of the product, for instance, several factors limit the application of value engineering. The design engineer is primarily motivated by the pressures to develop a product to meet performance specifications. He is trained to think in terms of safety margins rather than in terms of costs.[3] One observer notes that the design engineer's rewards are generally related to performance, not cost:

> The designer is rarely praised for doing a good job on cost or criticized for doing a bad job on cost. He is highly praised for releasing a design that meets performance requirements and is criticized for either missing a schedule or failing to produce a design that will perform. Naturally,

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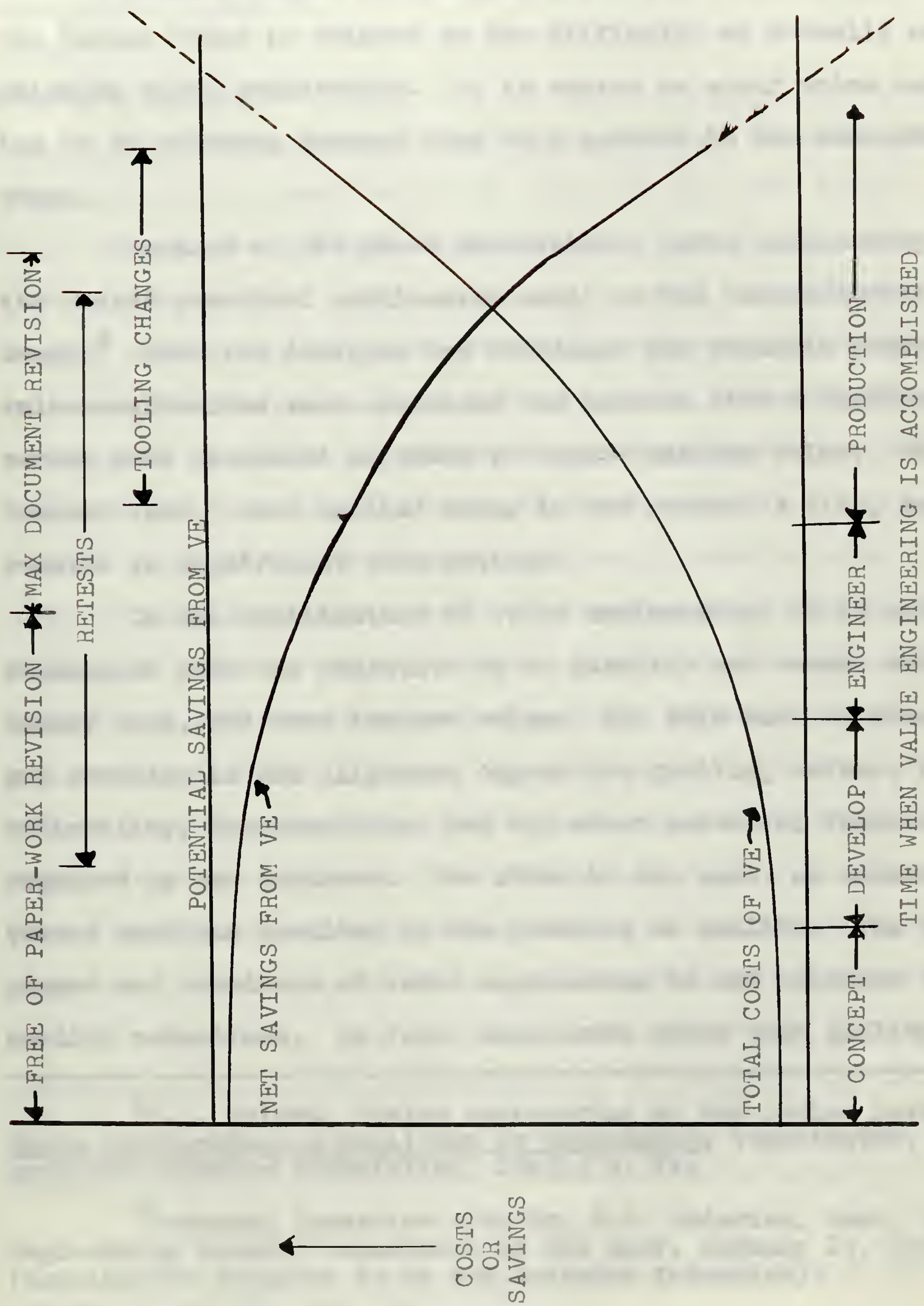
[1] Value Engineering Handbook, op. cit., p. 24.

[2] Harry O. Huss, Value Analysis (Value Engineering), (Army Chemical Center, Md.: U.S. Army Biological-Radiological Engineering Group, 1961), p. 6.

[3] Personal interview with Mr. John Moundalexis, Chief, Management Engineering Branch, Office of Management Services, Federal Aviation Agency, February 9, 1967.

Figure 3

Advantages of Early Value Engineering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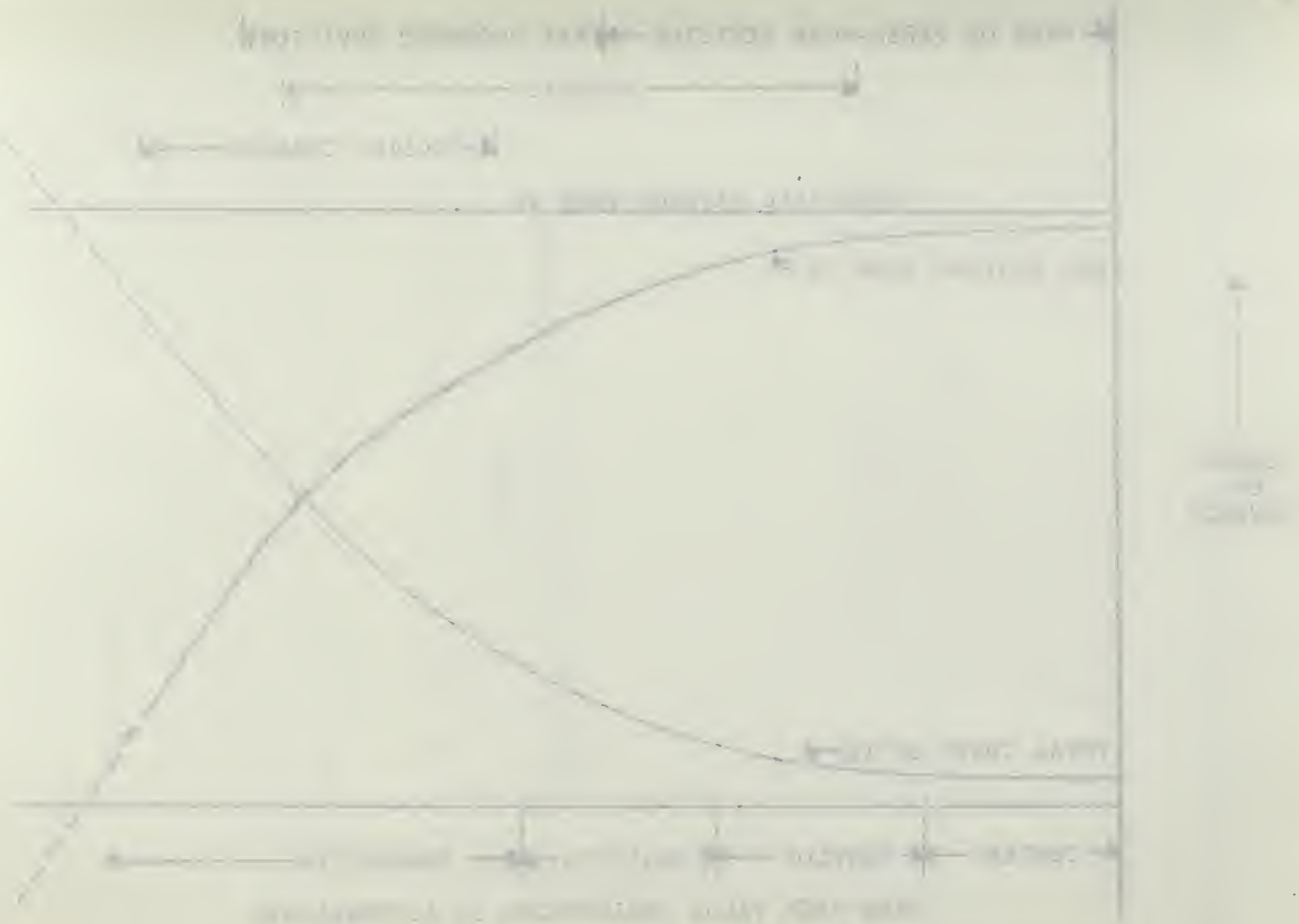

his interests are forced away from cost and almost entirely toward product performance.[1]

Another factor restricting the use of value engineering in the design stage is related to the difficulty of actually accomplishing value engineering. It is easier to apply value engineering to an existing product than to a product in the conceptual stage.

Because of the above constraints, value engineering finds its widest practical application early in the manufacturing stage.[2] Once the designer has developed the workable product, a value-engineering team appraises the product from a functional versus cost viewpoint in order to assure maximum value. This "second look," when applied early in the product's life, generally results in significant cost savings.

In all applications of value engineering, it is again emphasized that the objective is to identify and remove unnecessary cost, and thus improve value. All this must be done without reducing in the slightest degree the quality, safety, life, reliability, dependability, and the other essential features required by the customer. Too often in the past, an endeavor to remove cost has resulted in the lowering of quality. The techniques and standards of value engineering do not tolerate such quality reductions. In fact, experience shows that quality is

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[1]H.I. Knight, "Value Engineering at the Design Level," Value Engineering--A Challenge to Management, (Washington, D.C.: American Ordnance Association, 1963), p. 11.

[2]Personal interview with Mr. M.D. Roderick, Head, Value Engineering Branch, Department of the Navy, January 23, 1967, (hereinafter referred to as the Roderick Interview).

frequently increased as a result of developing alternatives for the accomplishment of desired function.[1] This will be discussed further in Chapter V.

State of the Art

The theory of value engineering has not changed substantially since its inception by Mr. Miles in the late 1940's. It still starts with a simple idea--evaluate a product in terms of what it does, not in terms of how it is made. Its objective is to find another way of doing the same job, but one that will do it more efficiently, and for much less money. Through the years a number of ingenious approaches have been devised to apply these simple techniques to whole range situations.

After a period of slow, but steady, growth, value engineering has hit its stride. New programs are mushrooming throughout industry and the results are being recorded in the millions of dollars. There are countless reports of value-engineering savings.[2] Behind the new spurt are greater competitive pressures, plus management's realization that value engineering can really deliver the goods.

Many large companies now have formal value-engineering programs, including regular training programs for key employees of all departments. For instance, Westinghouse has adopted a formal program of value engineering as an integral part of its cost-improvement program. It has reported savings in the

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[1] Roderick Interview, loc. cit.

[2] The magazine, Purchasing, devotes one issue a year to value-engineering case histories.

millions of dollars from the program. Westinghouse President, D.C. Burnham, points to value engineering as a key element in the effort to provide better products to customers at lower costs.[1]

The unique feature of value engineering is that it is applicable to small as well as large companies. The Small Business Administration sums it up as follows:

> The aim--and the achievement--of value analysis is to reduce costs on the product or process it is applied to, and to do this without diminishing performance. Its principles and techniques will work as well for the "do-it-himself" small businessman as they do for the expert . . . . Regardless of the size of the firm, the approach is basically the same.[2]

Value engineering has long been recognized as a useful cost-reduction tool within the Federal Government. It has been suggested that value engineering was given its first start in the early 1950's in the Defense establishment with the Navy's Bureau of Ships.[3] The initial program was limited to in-house projects at Government-owned industrial facilities and bases.

The DOD in-house, value-engineering program has produced significant results in the past few years. As indicated in Table 1, audited savings have increased from $72 million in Fiscal Year 1963 to $459 million in Fiscal Year 1967. This is exclusive of the value-engineering savings realized through contractors.

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[1] Paul V. Farrell (ed.), "V.A. at Westinghouse: Better Products, Lower Cost," Purchasing, May 20, 1965, pp. 45-47.

[2] Daniel D. Roman, "Value Analysis for Small Business," Technical Aids for Small Manufacturers, (Small Business Administration, May--June, 1964), p. 1.

[3] Roderick Interview, loc. cit.

The goal is a $500 million annual savings by Fiscal Year 1967.[1]

TABLE 1

ANNUAL ESTIMATED SAVINGS FROM THE DEPARTMENT OF DEFENSE IN-HOUSE VALUE-ENGINEERING PROGRAM[a]

Fiscal Year	Estimated Savings (millions)
1963	$ 72.0
1964	233.3
1965	298.1
1966	459.0

[a]Source: U.S., Department of Defense, Records of the Office of the Assistant Secretary of Defense for Installations and Logistics.

One DOD official states that despite the impressive gains, the overall value-engineering potential in the Department of Defense is several times as great as actual achievement. To approach the full potential, a number of new actions are underway. These actions include the allocation of 265 additional value-engineering billets in the three Military Departments and the Defense Supply Agency.[2] This includes approximately 90 billets assigned to the Department of the Navy.[3] In Chapter IV, the DOD in-house, value-engineering program will be compared with the value-engineering effort in Defense contracts.

Summary and Conclusions

Value engineering is an organized effort that looks at

[1]Kempter Interview, loc. cit. [2]Ibid.

[3]Roderick Interview, loc. cit.

the function of a product rather than the product itself. It attempts to identify areas of excessive or unnecessary costs, thereby improving value. It provides the same or better performance at lower costs, but does not reduce either the quality or reliability.

A successful value-engineering study begins with the proper choice of products with overall cost-reduction potential. Generally, value-engineering studies are directed toward high cost, highly complex items, and items produced in large quantities. The study then proceeds in a systematic step-by-step analysis of the problem and the development of a solution.

It is clear, from the evidence presented in this chapter, that the techniques of value engineering are well developed and have been proven useful as a cost-reduction tool. Large and small companies have realized significant cost savings by utilizing the techniques of value engineering. In short, the state of the art is well advanced. Thus, in using value-engineering incentives in contracts, the Government is not faced with developing or advancing the state of the art. It need only to motivate contractors to apply value-engineering techniques to defense products, thereby lowering overall procurement costs. The use of value-engineering incentives in defense contracts will be presented in Chapter IV.

CHAPTER IV

VALUE ENGINEERING CONTRACTUAL INCENTIVES

Introduction

Cost reduction and cost effectiveness, which currently characterize the entire spectrum of Department of Defense activities, were examined in Chapter II, which traced the efforts of the Government to harness the profit motive to work for the effective and economical performance of contracts. In Chapter III, value engineering was shown to be a powerful tool for attaining the objectives of cost reduction. It follows, then, that the Government can realize significant cost savings if defense contractors use value engineering. This chapter traces and analyzes the recent efforts of the Department of Defense to motivate industry to use value-engineering techniques when performing defense contracts.

Historical Background

Value-engineering incentive clauses were first incorporated in the Armed Services Procurement Regulation in 1959.[1] The Regulation specified that command approval was necessary for the incentive clauses to be used in contracts. Relatively little use was made of these initial value-engineering clauses, and the

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[1]ASPR, Revision 45 (1955 Edition), April 20, 1959.

resultant cost savings were insignificant.[1] In 1962, major emphasis was placed on the use of value engineering as part of the new DOD Cost-Reduction Program. To breathe new life into the program, the original incentive clauses were revised extensively. First, provisions were added which gave the Government the option to either require or encourage contractors to perform value-engineering studies.[2] In December, 1962, another revision grouped all contractual provisions concerning value engineering into a new Part 17, Section I of ASPR.[3] It also established requirements for the inclusion of value-engineering clauses in specific contracts.

The 1962 revisions contained little profit incentive relative to the cost risk involved in undertaking value-engineering studies. The result of the regulations was widespread refusal of contractors to accept the clauses and to participate in value-engineering efforts.[4] To cope with this resistance, a 1963 revision was made which offered more incentive by appeal to the profit motive.[5]

Early in 1964, the National Security Industrial Association polled a select group of defense contractors regarding their reactions to the most recent value-engineering incentives. The study revealed that 37 per cent of the 160 respondents felt that

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[1]Nash, op. cit., p. 106.

[2]ASPR, Revision 8 (1960 Edition), March 15, 1962.

[3]Ibid., Revision 13 (1960 Edition), December 9, 1962.

[4]Nash, op. cit., p. 106.

[5]ASPR, Revision 3 (1963 Edition), November, 1963.

"lack of real incentives" was a major roadblock, keeping the DOD value-engineering program from reaching its full potential. In addition, 52 per cent cited "short contractual periods" as a roadblock.[1]

This survey lead to further investigations and inquiries on the use of value-engineering incentives. The findings indicated that the contractors did not feel that incentives keyed solely to the reduction in the costs of the current program were sufficient to motivate full contractor participation. Based on this information, the DOD again revised and broadened the incentives. The new clauses, which were announced in Defense Procurement Circular No. 11, are those which are currently in force.[2]

Contractual Provisions

The Armed Services Procurement Regulation currently lists two kinds of value-engineering provisions: (1) value-engineering incentives which provide for the contractor to share in cost reductions that ensue from change proposals he submits, and (2) value-engineering program requirements which obligate the contractor to maintain value-engineering efforts in accordance with an agreed program, and provide for contractor sharing in cost

[1]George E. Fouch, "The Way of Value Engineering Incentives," Proceedings of the Series of Briefing Sessions on Defense Procurement Circular No. 11, (Washington, D.C.: Society of American Value Engineers, 1965), p. 10.

[2]U.S., Department of Defense, Defense Procurement Circular No. 11, October 9, 1964.

reductions ensuing from change proposals he submits.[1]

Incentive Type. The objective of the value-engineering, incentive-type provision is to encourage the contractor to develop and submit to the Government proposals for changes in the contract specification, purchase description, or statement of work which would reduce the overall cost of the contract, or otherwise result in collateral savings to the Government. Generally, the changes submitted under this provision are aimed at the elimination or modification of any requirements found to be in excess of actual needs. Under the value-engineering clauses, a contractor submits a cost-reduction change proposal. If the Government accepts the proposal under this provision, the Government and the contractor share in the resulting overall cost savings. The basis for the sharing formula is discussed later in this chapter.

The Procurement Regulation requires that, with several exceptions, a value-engineering, incentive-type clause be included in all contracts in excess of $100,000.[2] The significant exceptions are: (1) certain cost-reimbursement contracts, (2) commercial products where the design and cost are controlled by the commercial market, (3) where a value-engineering, program-type clause is in the contract, and (4) when the head of the procuring activity determines that value engineering offers no potential cost reduction.[3] The value-engineering, incentive-type clause may also be included in certain contracts under $100,000.

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[1]ASPR, 1-1701. [2]Ibid., 1-1702.3(a).

[3]Ibid.

Program Type. The value-engineering, program-type provision differs from the incentive-type provision in that it obligates the contractor to engage in value engineering at a level of effort determined by the Government and stated as an item of work in the contract schedule. The program-type provision requires a continuing value-engineering effort by the contractor and the submission to the Government of reports reflecting the results of such effort.[1]

ASPR states that the principle reason for requiring a formal value-engineering program is to get earlier results; i.e., in the initial stages of the design, development, or production so that the specifications, drawings, and production methods will reflect the full benefit of value engineering.[2] The program-type clause, like the incentive-type, provides for sharing of savings resulting from the adoption of change proposals.

The program-type clause must be included in all CPFF contracts in excess of one million dollars unless specifically exempted by the head of the procuring agency. Also, in special cases where the lack of a firm job description exists, the program-type clause may be substituted for the incentive-type clause in CPIF contracts. In no case, however, may a program-type clause be included in a formally advertised contract.[3]

Sharing Plan. Experience with earlier value-engineering contractual provisions clearly demonstrated that cost reduction can only be effective when the contractor is truly motivated to

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[1]ASPR, 1-1702.2. [2]Ibid.

[3]Ibid., 1-1702.3(b).

utilize the techniques of value engineering. This motivation was sought in later revisions by strengthening the appeal to the profit motive. The provisions announced by Defense Procurement Circular No. 11 contained two principal elements. First, the contractor must be assured of a fair proportion or share of any value-engineering savings; and second, he must be assured that his share will be applied to a substantial base.

In an effort to fully exploit the large cost-reduction potential of value engineering, the following policy was established:

> It is Department of Defense policy to be generous in incentive arrangements so long as it is assured that it is being generous only with definite cost-reduction savings. This policy reflects the facts that the Government will benefit from any value-engineering savings, the definitely assured savings from successful value engineering are likely to be only a part of the overall savings and a generous incentive tied to definitely assured savings offers maximum likelihood of the Government realizing the full overall savings potential.[1]

Under the earlier provisions, contractors were often reluctant to invest in value-engineering programs because the sharing of realized savings was limited to a small base; i.e., the current contract. Contractors considered this to be unfair, especially since the Government's savings extended to all future contracts. The revised regulations were designed to eliminate this inhibiting feature by providing for contractor sharing of future acquisition savings.[2] The current clauses provide that the sharing period may be as much as three years, but in no event should it be less than one year. In addition, provisions were

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[1]ASPR, 1-1703.1(b). [2]*Ibid.*, 1-1703.3.

made to facilitate contractor sharing where collateral savings in operations, logistic support, and other areas may accrue to the Government.[1]

The precise extent to which the contractor shares in the cost must be tailored to the particular procurement. The percentage of the savings which goes to the contractor is proportional to the risk he assumes under the contract. Contracts with the incentive-type clause provide for the greatest contractor percentage share. In fixed-price-type contracts, and contracts awarded under adequate price competition, the contractor's share is normally 50 per cent and may be as much as 75 per cent. This percentage varies according to the certainty of estimated savings. Normally, the contractor's percentage share in future acquisition savings is considerably less than those on the current contract.[2]

In contracts with the value-engineering, program-requirement-type clause, the share of the cost savings is much smaller. It ranges from a maximum of 25 per cent in an FPI-type contract to 5 per cent in a CPFF-type contract.[3] These low percentages reflect the fact that the cost of the contractor's value-engineering effort requirements is taken into account when the contract price is negotiated.

Cost-Reduction Proposals. Value-engineering contract clauses apply only to cost-reduction proposals which require a change to the contract. The proposal is submitted in the form of a Value Engineering Change Proposal (VECP).[4] The contractor

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[1]ASPR, 1-1703.4.

[2]*Ibid.*, 1-1704(c).

[3]*Ibid.*, 1-1704(c).

[4]*Ibid.*, 1-1706.

made on [illegible] [illegible]
[illegible]

[illegible]

In contrast with the price-redetermining, fixed- [illegible] [illegible] similar. It ranges from a maximum of [illegible] contract to [illegible] contract.[7] These low percentages reflect the fact that the bulk of the contractor's [illegible]

[illegible]

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[4]Ibid., [illegible]. [6]Ibid., [illegible].

[5]Ibid., [illegible]. [7]Ibid., [illegible].

includes in the VECP all the details of the recommended change in the contract's specifications and the requirements which lead to a cost reduction. An estimate of the resultant savings is also included in the VECP.

The Government carefully evaluates the VECP and confirms or modifies the savings estimated by the contractor. If the VECP is accepted, the Government becomes the owner of all the amended drawings, specifications, and other related ideas, and may use them in future contracts with the same, or other contractors.

Contractor Funding

Comprehensive value-engineering programs add significant overhead to the cost of performing a contract. Under the value-engineering, incentive-type clause, the Government encourages, but does not require, a value-engineering program. For this reason, the contractor bears all the costs of his value-engineering efforts. However, he is allowed up to 75 per cent of the cost savings resulting from his efforts. This high percentage reflects consideration of the contractor's financial risk in the performance of studies which lead up to the opportunity to share cost savings.

In contrast with the program-requirement-type clause, the contractor's costs to conduct a formal value-engineering program is reflected in the overall contract price. The Government places no maximum limits for direct funding of contracts with the mandatory value-engineering requirement. However, over a period of time, the ratio of net savings achieved to costs incurred should exceed 10 to 1; in other words, for every dollar spent for

value engineering, the activity should recover ten or more dollars.[1]

In negotiating a contract with a program-requirement-type clause, the negotiators must determine a reasonable level of value-engineering effort. At this stage, the 10 to 1 ratio criterion does not help the negotiators. In such cases, the initial program level is normally set between 1/10 of 1 per cent and 1/2 of 1 per cent of the total annual dollar volume of the contract.[2] As experience with the contractor's value-engineering efforts is gained, the funds allotted to value-engineering studies may be based on the contractor's past performance.

Subcontractor Effort

The new contract regulations announced in Defense Procurement Circular No. 11 specifically encourage subcontractor value-engineering programs. The prime contractors are expected to encourage their subcontractors to fully utilize value-engineering techniques. In return, the subcontractors' costs of implementation and portion of value-engineering sharing are recognized by the Government as part of the prime contractor's cost to implement the VECP.[3]

Potential Cost Savings

Experience indicates that an intensive value-engineering effort can produce cost savings of 15 to 25 per cent.[4] The DOD

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[1] DOD Value Engineering Handbook, op. cit., p. 36.

[2] Ibid. [3] ASPR, 1-1707 to 1-1708.

[4] Miles, op. cit., p. 1.

in-house programs have achieved up to 35 per cent cost savings on individual products.[1] These percentages, which are supported in part by the evidence presented in Chapter III, give some indication of the magnitude of the potential savings that may be realized from defense contractor value-engineering programs.

The following example attempts to quantify this potential. In Chapter I it was pointed out that DOD contract expenditures exceed $30 billion annually. Suppose that less than one-third, or $10 billion worth of these contracts can be value engineered. Also, suppose that only a modest 10-per cent cost reduction is achieved on this $10 billion. Using these conservative assumptions, the potential overall savings is about one billion dollars annually. Even if the contractor shares in only 25 per cent of this savings, the potential profit pool is $250 million. Considering that the illustration is conservative on all estimates, one DOD official observed that value-engineering incentives offer the contractor a virtual "hunting license" to reap vast profits.[2]

Industry Acceptance

Defense Procurement Circular No. 11 is the most recent major revision of the value-engineering clauses. This circular was based on five years' experience with value-engineering incentives and was a major attempt to reconcile the interests of industry and Government. Since publication of the circular, the revised value-engineering clauses are being included in new

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[1] Fouch, *op. cit.*, p. 12.

[2] Kempter Interview, *loc. cit.*

contract awards, and many existing contracts are being modified to incorporate the new clauses.[1]

The response to the new clauses can be regarded as favorable. The figures in Table 2 indicate that the cost savings have almost doubled in three years. But the program is still very light when compared with the results of the DOD in-house, value-engineering program (see Table 1, page 45). For instance, the DOD in-house program had cost savings of $459 million in Fiscal Year 1966, as compared to the contractor program savings of $36 million in the same period.

TABLE 2

ANNUAL ESTIMATED SAVINGS FROM THE DEPARTMENT OF DEFENSE CONTRACTOR VALUE-ENGINEERING PROGRAM[a]

Fiscal Year	Savings (before sharing) (millions)
1964	$ 18.7
1965	28.9
1966	36.0

[a]Source: U.S., Department of Defense, Records of the Assistant Secretary of Defense for Installations and Logistics.

The earlier value-engineering provisions in defense contracts were essentially a one-sided affair. The Government was the principal beneficiary of the program, with industry receiving little benefit for its cost-reduction efforts.

[1]Fouch, op. cit., p. 11.

Although the Government has since become more generous by giving the contractor more of a share of the savings, it remains for much of industry to be convinced of this shift in policy. A DOD official has observed that those contractors who have reaped profits under the new provisions are the most enthusiastic supporters of the program. But too many contractors still regard it as just another cost-reduction program which offers them little financial reward.[1]

To stimulate new interest, DOD officials regularly conduct value-engineering seminars, conferences, and briefing sessions in major cities. The purpose of these sessions is to explain the procedural aspects of the value-engineering clauses and gain industry's acceptance of them. The sessions also give DOD officials an opportunity to hear industry's suggestions for strengthening the program.[2]

The annual increase in cost savings indicates that these efforts have been at least a partial success. But industry still voices a number of valid criticisms of the program. A representative of one missile firm reported that when negotiating a fixed-price contract, every time his firm suggested a value-engineering, cost-savings proposal, the Government negotiators told them to "cut that much more out of your price."[3] Other firms complain that the incentive environment, while promising higher profits, also requires increased capital expenditures and

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[1]Kempter Interview, loc. cit. [2]Ibid.

[3]"Defense Digest," Armed Forces Management, Dec., 1964, p. 15.

research in order to be prepared for Government requirements. One industry executive observed that value-engineering programs put a drain on profit dollars because the Government negotiators and the Renegotiation Boards often do not allow recovery of these costs.[1]

Defense officials recognize that improper or poor administration by Government contracting officers tends to negate industry incentive. Local contracting officers are not fully aware, or do not fully understand, the policies and objectives of the value-engineering incentive clauses. To correct this situation, considerable emphasis is placed on educating and informing key procurement officials of the value-engineering policies and requirements. Formal DOD in-house courses are offered to these officials, and periodic conferences and training sessions are conducted.[2]

Appraisal

Value-engineering incentives are not like other contract incentives which provide rewards for performing efficiently in accordance with the stated terms of the contract. Rather, they are rewards to the contractor for exercising initiative and technical ingenuity in identifying and successfully challenging the stated terms of the contract, where those terms contain costly and unessential restrictions. Industry has for many years complained

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[1]Louis J. D'Amore, "Will Total Incentive Picture Mean Industry Rags or Riches?", Armed Forces Management, Aug. 1965, pp. 57-60.

[2]Kempter Interview, loc. cit.

of unrealistic Government requirements and specifications in contracts. The value-engineering provisions of the Armed Services Procurement Regulation offers the contractors an opportunity to challenge those terms of the contract which contain costly and unessential restrictions. The contractor is afforded an opportunity to realize substantial profits while performing more efficiently.

The current value-engineering incentives reflect the fact that the taxpayer is not going to benefit unless the contractor accepts the value-engineering challenge. The earlier clauses failed as a cost-reduction tool because they channeled most of the potential benefits to the Government. The current regulations are more realistic. They specify that the Government's policy is to be generous in sharing the savings with the contractor. The regulations are designed to encourage full participation by contractors, large and small. Since large-scale, widespread use of value engineering will achieve substantial savings for the taxpayer, the Government need not be concerned if the contractor also realizes a generous share of the savings.

The value-engineering program got off to several false starts in the early 1960's. The eagerness to obtain results and the lack of experience in applying some of the procurement concepts resulted in contractual provisions that were impractical or ineffective. Recent revisions of the regulations have corrected many of the earlier defects. The value-engineering clauses now appear to adequately harness the profit motive to work for effective performance. The weakness of the program now appears

to center around the administration of the program rather than the contractual clauses. An educational program to inform Government contract administrators of the objectives of the value-engineering clauses should correct this weakness.

Conclusions

Value engineering is no longer an experimental program based on vague regulations. The Government has clearly demonstrated its determination to use value engineering as a major cost-reduction tool in defense contracts.

This thesis questioned the value-engineering profit potential open to contractors. It is evident that the Government is now resolved to be generous with the contractors when sharing cost savings. A contractor may realize up to 75 per cent of the total estimated savings. The savings base, to which this percentage applies, has been expanded to include future acquisition and collateral savings. Thus, on the basis of a sharing formula, the potential profit is good.

In this chapter, an attempt was made to calculate the total annual profit open to industry. Using very conservative figures, the annual estimated cost savings was determined to be about one billion dollars, of which 25 per cent represented the contractor's profit potential. The writer concedes that the above figures are only crude estimates of the profit potential and are based on a very small sample of value-engineering results. But they do serve as an indication of the huge profit potential for contractors who are willing to undertake aggressive value-engineering programs.

Cost savings for the Government and increased profits for the contractor are the most obvious benefits from value engineering. Yet, there are many other benefits, direct and indirect, which accrue to both parties. These benefits will be considered in detail in the next chapter.

CHAPTER V

RESULTS AND BENEFITS

Introduction

In the preceding chapters, some of the results and benefits of value engineering have been mentioned. The purpose of this chapter is to examine in detail the potential benefits which accrue to the Government and to the contractor through the use of value engineering in defense contracts.

For discussion purposes, the results and benefits are classified as direct and indirect. The direct results and benefits are those which can be measured in terms of dollars which are shared by the Government and the contractor. The indirect benefits are those which cannot be, or are not, measured in terms of dollars. They are often classified as fringe benefits of a value-engineering program.

Within each of the above classifications, the benefits to the Government and to the contractor are examined separately. This is done with the knowledge and understanding that, in practical application, both parties may receive identical benefits from a given value-engineering effort.

Direct Benefits

Government. The total annual direct benefits of a contractor value-engineering program are listed in Table 2 on page

57. These benefits are quantified in terms of dollars and shared with the contractor in accordance with the terms of the contract. The cost savings represent a reduction in the cost of the current contract, a reduction in the cost of follow-on purchases, collateral savings, or any combination of the three.

Five representative value-engineered products are graphically illustrated in Appendix I. Each product is shown before and after it was value-engineered, together with an estimation of the cost savings. In some instances the unit cost reduction is small, but the total savings is significant because of the volume of items to which the value-engineering change applies.

The exhibits in Appendix I do not disclose any pattern or classification of items that can be value-engineered. Successful value-engineering efforts are so numerous and so diversified that any grouping or classification is impossible. But one characteristic does stand out. This characteristic is the seeming simplicity of the change which resulted in lower costs. When viewing before-and-after exhibits, one wonders why these simple ideas weren't incorporated in the product's original design. But as previously noted, time limitations imposed on a design engineer, particularly in defense contracts, usually do not allow him sufficient time to consider the product in terms of value.[1] This demonstrates the need for the second look at a product in a systematic manner by personnel who consider the product primarily in terms of value. It is this second look that results in

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[1]Roderick Interview, <u>loc. cit</u>.

substantial direct cost savings.

Recently, the Department of Defense undertook a Value-Engineering Genesis Study to determine what factors lead to the greatest cost savings.[1] The study was accomplished by the DOD on a sample of 415 successful Class I and Class II value-engineering changes during Fiscal Year 1965. Class I changes are those which require a modification in the prime contract, whereas Class II changes require no such modification. Areas of study included value-engineering efforts which were prompted by additional design effort, excessive cost of product, questioning specifications and changes in the user's needs. The study indicated that rarely does any single factor cause value-engineering cost savings. For example, it was found that in Class I changes, excessive cost of the current design of a product and the questioning of specifications accounted for 56 per cent of the savings. In the Class II changes, additional design effort and excessive cost of current design accounted for 42 per cent and 16 per cent of the savings, respectively. A complete summary of the findings of the Genesis study is contained in Figure 4. Definitions of the terms used in the study are contained in Appendix II.

The direct benefits to the Government, expressed quantitatively in dollars saved, is the major objective of the value-engineering incentive clauses.[2] The indirect or fringe benefits

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[1]U.S., Department of Defense, Value Engineering Genesis Study, (Washington, D.C.: Office of the Assistant Secretary of Defense for Installations and Logistics, 1966).

[2]Kempter Interview, loc cit.

Figure 4

Factors Leading to Value-Engineering Changes

PLATE I

DOD CONTRACTORS
(116 CLASS I CHANGES)

Factor	No. Times Cited	Total Saving (thousands)	Factor
Excessive Cost	75	$ 5,736	Excessive Cost
Questioning Specification	53	5,453	Questioning Specification
Additional Design Effort	42	4,938	Advances in Technology
Advances in Technology	33	1,646	Additional Design Effort
Feedback from Test/Use	21	860	Change in User's Need
Change in User's Need	16	832	Feedback from Test/Use
Design Deficiencies	11	421	Design Deficiencies
Totals	251	$19,886	

PLATE II

DOD CONTRACTORS
(201 CLASS II CHANGES)

Factor	No. Times Cited	Total Saving (thousands)	Factor
Additional Design Effort	162	$ 7,786	Additional Design Effort
Excessive Cost	81	2,967	Excessive Cost
Advances in Technology	62	1,974	Questioning Specifications
Questioning Specifications	28	1,668	Advances in Technology
Feedback from Tests/Use	16	911	Feedback from Tests/Use
Design Deficiencies	9	123	Design Deficiencies
Change in User's Needs	8	86	Change in User's Needs
Other	37	2,578	Other
Totals	403	$18,093	

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

of the incentive clauses are valuable, but are secondary to their cost-reduction features.[1] It is apparent, therefore, that the Government considers the direct benefits or cost savings to be the primary justification for the program.

Contractor. It has been stated that the sharing arrangements are such that the contractor never benefits unless the Government benefits.[2] This is especially true when considering the direct-dollar benefits which the contractor receives from successful cost-reduction proposals. The contractor share of the savings acts to increase the total profit of the contract.

It was pointed out in Chapter IV that contractors did not respond to the early incentive provisions because their share of the direct cost savings was small. But as their share was increased, their value-engineering effort improved. It appears, therefore, that the contractors' share of the direct cost savings is the primary incentive to them to engage in value engineering.

Indirect or Fringe Benefits

Generally, indirect or fringe benefits cannot be accurately measured in terms of dollars, but they are an important element in the contractor's profit picture and the Government's quest for economy. For this reason, the cost-reduction aspect of value engineering, however important in itself, should not be the sole reason for encouraging or engaging in a value-engineering

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[1] Every comprehensive article on value engineering researched by the writer placed major emphasis on the use of value engineering as a cost-reduction tool.

[2] Fouch, op. cit., p. 13.

program.

Government. Value engineering results in better defense products. This is the most important fringe benefit of the contractor value-engineering program. Product improvement is possible because the value-engineering effort normally simplifies the design of the product.

The growing complexity of military products and weapons systems makes it increasingly difficult to maintain a high standard of product reliability and maintainability. The desire for more sophisticated weapons is necessary, but it often results in performance overkill--performance for performance's sake.[1] The high performance characteristics of individual components are often far beyond the useful capability of the system of which it is a part. Value engineering simplifies the product by eliminating or reducing the number of parts involved. In theory, this improves its reliability, maintainability and performance.

This theory is supported by a study conducted by the American Ordnance Association.[2] The Association studied 124 representative samples of implemented value-engineering changes to determine the effect of the changes on the product. The results indicated improved reliability in 44 per cent of the cases studied, improved quality in 38 per cent, and improved maintainability in 40 per cent. Also, in 21 per cent of the cases, performance was actually improved. In only 3 per cent of the cases

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[1] Roderick Interview, loc. cit.

[2] U.S., Department of Defense, Fringe Effects of Value Engineering, (Washington, D.C.: U.S. Government Printing Office, 1964), pp. 10-18.

systems.

[illegible]. These measurement results in certain categories [illegible]. This is the most important single result of the [illegible] studies of [illegible] systems. Problem determination is possible through the value-engineering effort normally [illegible] the design of the product.

The general philosophy of military research and development systems is increasingly difficult to establish a value group and it defined reliability and maintainability. The [illegible] more complicated [illegible] is necessary, and it [illegible] possible to performance [illegible] requirements for performance [illegible].[1] [illegible] high performance characteristics in [illegible] components [illegible] where the higher the [illegible] capability of the [illegible] which is is a must. Value engineering [illegible] the product or eliminating or reducing the number of parts involved. In theory, this improves its reliability, maintainability and performance.

This theory is supported in a study conducted by the [illegible] [illegible] Association.[2] The investigation [illegible] representative results of [illegible] value-engineering programs to determine the effects of the changes on the product. The results indicated improved reliability in [illegible] per cent of the items studied, improved quality in [illegible] per cent, and improved maintainability in [illegible] per cent. Also, in [illegible] per cent of the cases, performance was actually improved. In only 1 per cent of the cases,

[1] [illegible], loc. cit.

[2] [illegible], Department of [illegible], [illegible] Effects of Value Engineering, [illegible], [illegible], 1963, pp. 10-15.

did functional performance decrease. A graphical summary of the findings of the study is contained in Figure 5. Definitions of terms used in the study are contained in Appendix III.

The contribution of value engineering to the performance, reliability and maintainability of defense products is a highly desirable fringe benefit. However, this feat in itself is not impressive. There are many programs which improve the performance and characteristics of products. But there are few that boast of such accomplishments at a net cost savings.

Contractor. The indirect or fringe benefits for the contractor are no less impressive than those which accrue to the Government. Some of these benefits are obvious, while others can only be speculated upon.

One valuable by-product is an improved, cost-conscious atmosphere throughout the company. This is a highly desirable result, since the lack of this climate is an environmental factor that originally prompted the need for value engineering. This improved atmosphere contributes to profit in such a way that the value-engineering program never receives the credit. One authority accepts this lack of recognition as normal. He cites the following example:

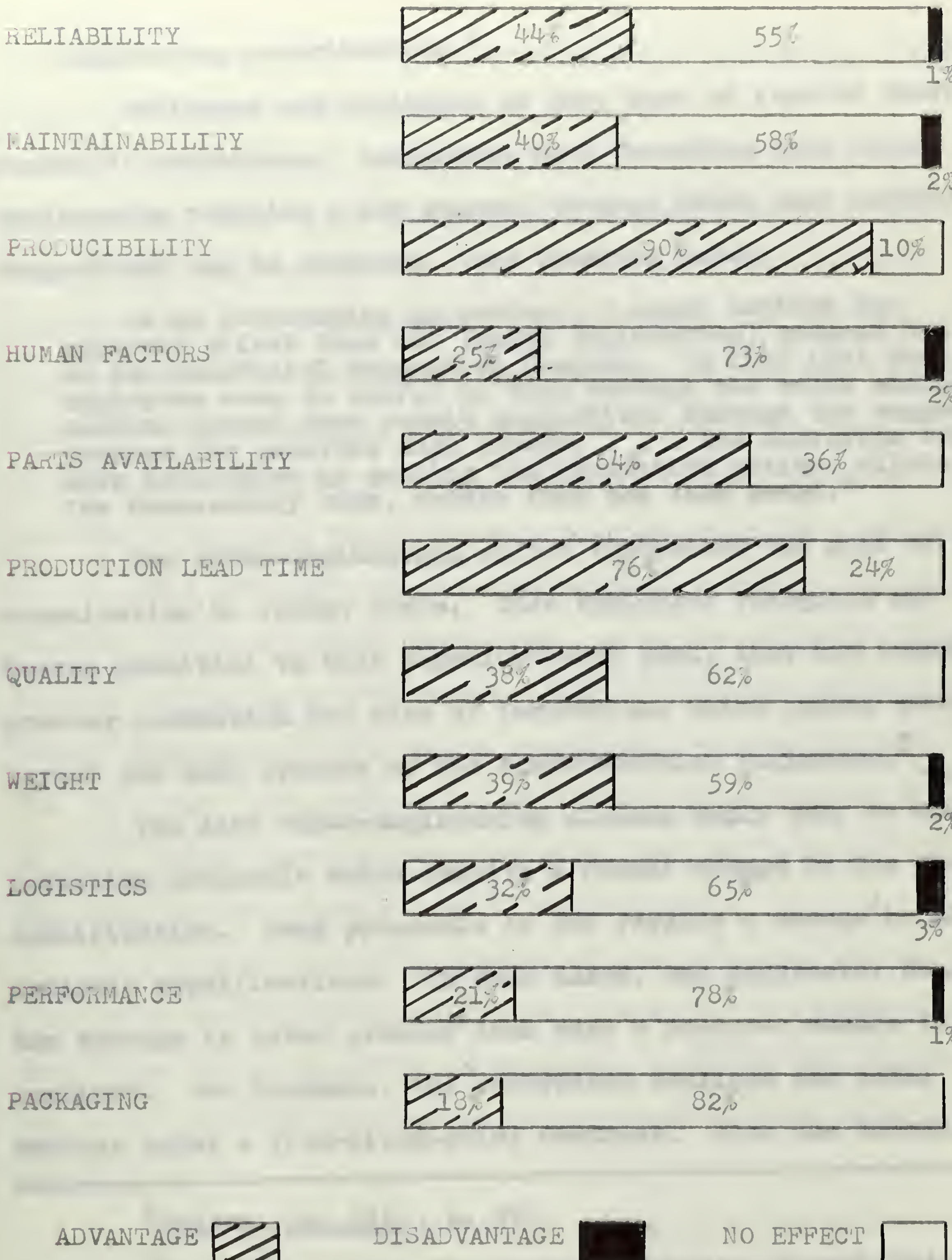
> . . . as the result of attending a value engineering training course, an administrator, after taking a function-oriented look at the paperwork activity of his section, may decide to eliminate many useless forms, reports, and records. This may result in significant savings both in terms of people's time and in materials purchased. But the savings will usually not be chalked up to value engineering. This is not to say that the value engineering group should, or even wants to, take credit for this profit contribution. What is important is that management recognize that such contributions do exist, even though they cannot be measured as value

Figure 5

Value-Engineering Fringe Effects
(Class I & Class II Changes Consolidated)

[illegible]

[illegible]
[illegible]


RELIABILITY
44%
55%
1%
MAINTAINABILITY
40%
58%
2%
PRODUCIBILITY
90%
10%
HUMAN FACTORS
25%
73%
2%
PARTS AVAILABILITY
64%
36%
PRODUCTION LEAD TIME
76%
24%
QUALITY
38%
62%
WEIGHT
39%
59%
2%
LOGISTICS
32%
65%
3%
PERFORMANCE
21%
78%
1%
PACKAGING
18%
82%
ADVANTAGE
DISADVANTAGE
NO EFFECT

engineering contributions.[1]

Employees are motivated in many ways to improve their company's operations. Management must recognize that value engineering provides a new channel through which many helpful suggestions may be received. One observer noted:

> As an interesting by-product, I might mention the apparent effect that our [value engineering] program has had on the Beneficial Suggestion Program. We find that the employees seem to prefer to work through the value analysis program rather than submit suggestions through the suggestion program for possible cash awards. . . . the employees seem more interested in getting the corrective action, eliminating the unnecessary work, rather than the cash award.[2]

The value-engineering effort emphasizes the goal of the organization to reduce costs. Once employees recognize and become committed to this organizational goal, they are capable of greater production and also of innovations which reduce costs far beyond the best efforts of the cost-reduction engineers.[3]

The ASPR value-engineering clauses apply only to cost-reduction proposals which require a formal change in the contract specification. Many proposals do not require a change in the contract specifications. In such cases, the contractor share of the savings is often greater than when a contract change is required. For instance, the contractor realizes the total savings under a firm-fixed-price contract. With the increased

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[1]Falcon, op. cit., p. 96.

[2]L.B. St. Petery, "Employee Motivation Through Value Analysis," DOD In-House Value Engineering Conference, February, 1964, (Washington, D.C.: U.S. Government Printing Office, 1964), p. 45.

[3]Edgar H. Schein, Organizational Psychology, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 59.

emphasis on fixed-price-type contracts, this potential fringe benefit is highly significant.

The Government is now taking into consideration the contractor's past performance when selecting future contract sources and when negotiating profit levels. Under recently revised rules, the contractor's value-engineering activities in past contracts are considered in awarding new negotiated contracts.[1] This provision enables the contractor to receive additional recognition for his value-engineering efforts. It provides a valuable fringe benefit for the superior contractor.

Cost overruns are always a nagging problem, especially in research and development contracts. An active value-engineering program in the early development stages helps the contractor reduce unnecessary costs which contribute to cost overruns.[2] The fact that this application of value engineering may not show up in a formal cost-reduction proposal does not make it any less important to the overall good of the company.

The above are only samples of the potential fringe benefits of an active value-engineering program. It is not important that these fringe benefits be carefully measured and recorded. But it is important that management recognizes that they do exist.

Conclusions

Value-engineering benefits extend far beyond the scope of

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[1] U.S., Department of Defense, Guide to Contractor Performance Evaluation, (Washington, D.C.: U.S. Government Printing Office, 1966), p. 32.

[2] John Van de Water, "VA 1965: New Growth, Bigger Pay-Off," Purchasing, May 20, 1965, p. 39.

the formal value-engineering program. With the limited resources available for national defense, a program that provides better products at lower cost ultimately means better national defense. For the contractor, the value-engineering effort lowers the price of his products, thereby making him more competitive when bidding on future defense and nondefense contracts. These, and the many other direct and fringe benefits, make value engineering a highly attractive cost-reduction tool.

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CHAPTER VI

PROBLEMS AND IMPLICATIONS

Introduction

Considering the favorable attributes of the contractor value-engineering program which are enumerated in Chapter V, the results thus far have not been impressive. The direct cost savings in Fiscal Year 1966 of $18.7 million are only a fraction of the total potential. When compared with the results of the DOD in-house program, which produced savings of $459 million in the same year, the results are rather disappointing.

This meager showing does not discredit value engineering, which has been proved to be an effective cost-reduction tool. Rather, it suggests that there are constraints within the contracting environment which tend to negate the incentive to conduct a full-fledged value-engineering program. Some of these constraints are required in the interests of the overall procurement activities. Others are not. This chapter examines some of the problem areas and the implications of these problems for the future of the value-engineering program.

Multiple Incentives

Value-engineering incentives are just one of a large family of cost-reduction incentives used by the Government to obtain economy in procurements. The cost savings realized by

shifting from non-competitive to competitive procurements and the greater use of FFP-, FPI- and CPIF-type contracts were examined in Chapter II. Some of the new incentive arrangements include Project Definition, Multi-year Procurement, Weighted Guidelines, and the Total-Package-Procurement Concept (TPPC). TPPC is a complex contract arrangement developed by the Air Force and used for the first time in the multi-billion-dollar C-5A program.[1]

Increased competition and the use of incentive-type contracts are credited with the greatest portion of cost savings in defense procurements.[2] However, the incentive-type contracts enumerated above focus the profit motive on profit earned on a single contract by bettering the specific goals set forth in that contract. These complex incentive arrangements are generally limited to large research and development contracts and other multi-million-dollar procurements. Value-engineering incentives, on the other hand, are applicable to a wide cross section of Government contracts, both large and small.

In any specific large contract, the savings potential through value-engineering incentives is relatively small when compared to the other cost-reduction and cost-prevention incentives. For this reason the benefits of the incentives are often

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[1] John Mechlin, "The Ordeal of the Plane Makers," Fortune, Dec. 1965, p. 158.

[2] DOD Cost Reduction Report, July 8, 1966, op. cit., pp. 8-15.

overlooked or relegated to a position of minor importance.[1] This is unfortunate, for even if the savings potential is not large when compared to the other incentives, it is still rather substantial in terms of dollars. Value-engineering incentives complement other incentives and are a vital element in the total cost-reduction effort.

Profit Redetermination

Value-engineering incentives afford the contractor an opportunity to realize significant excess profit over and above the normal profit usually earned under the Government contracts. The ingenious and efficient contractor who takes advantage of this opportunity has every right to anticipate sizable profits. But the knowledgable Government contractor is aware that this is not always the case.

There are several restrictions which prevent the contractor from earning excessive profits. Whether or not the profits can be retained depends ultimately on the position taken by the Renegotiation Board. Recognizing the uncertainties of this situation, the DOD, with the support of the National Aeronautics and Space Administration (NASA), has made a presentation to the Renegotiation Board covering the incentive program, with the view that the Board should favorably recognize these provisions when considering fair profits.[2]

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[1] Kempter Interview, loc. cit.

[2] C.C. Van Vechten and J.C. Ferren, "Contractual Aspects," Value Engineering--A Challenge to Management, (Washington, D.C.: American Ordnance Association, 1963), p. 7.

In Fiscal Year 1966, the Board made 21 determinations of excessive profits totaling $24,513,962.[1] From its inception in 1951, the Board has made 3,373 determinations of excessive profits totaling $936,455,823.[2] Determinations of excessive profits are made on the basis of aggregate profits of the contractor on all Government contracts for a full year. Favorable recognition is given to the efficiency of the contractor, with particular regard to the attainment of quantity and quality production, reduction of costs, and economy in the use of materials, facilities and manpower. Credit is also allowed for Federal and State income taxes.[3]

Thus, fiscal-year renegotiation, which deals with aggregate profits, is entirely different from price adjustment or redetermination of individual contracts pursuant to contract provisions. While in theory, value-engineering efforts are given favorable recognition, large profits attained through this effort may very well be lost in the Board's final determination of allowable profit.

An official of the Renegotiation Board states that the Board is inclined to give favorable recognition to efforts such as value engineering. But he believes that it is largely an academic problem because, to date, very few contracts have reflected large value-engineering profits.[4]

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[1]U.S., The Renegotiation Board, <u>Eleventh Annual Report</u>, (Washington, D.C.: U.S. Government Printing Office, 1966), p. 9.

[2]<u>Ibid</u>. [3]<u>Ibid</u>.

[4]Personal Interview with Mr. F.M. Dunkin, Office of Renegotiation Review, The Renegotiation Board, March 11, 1967.

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[illegible]

[illegible] Ibid.

[illegible] [illegible] 24, 1947.

The manner in which the Renegotiation Board evaluates the contractor's profit level makes it difficult to determine the Board's effect on value-engineering profits. But it is apparent that the mere presence of the Board has a discouraging effect on any contractor who has ideas about earning high levels of profit, legally or otherwise.

Administrative Problems

Most new programs encounter initial administrative difficulties. The value-engineering program is no exception.[1] Many of the early problems have been solved. Some of the current problems center around the processing of the cost-reduction change proposals. These proposals are processed by many different contracting officers throughout the country. It was pointed out in Chapter IV that these officers are often unfamiliar with the aims and objectives of the program. As a result, the proposals are occasionally treated with indifference or processed inconsistently with the real objectives of the program.[2] The training programs now being conducted by the DOD and the individual services should eventually eliminate these inhibiting factors.

Another very real administrative problem is the difficulty of estimating the true savings of a value-engineering change proposal and, as a result, the amount of money the contractor should receive for submitting the proposal. Since the savings base takes into account present, future, and collateral savings,

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[1] Kempter Interview, loc. cit. [2] Ibid.

a considerable amount of research and documentation is required to arrive at a fair determination. A contracting officer has wide latitude in determining the savings base. His interpretation of the Government policy to be generous can mean the difference between meager and substantial profits.

Prompt, consistent and fair administration of the cost-reduction proposals is a prerequisite if the value-engineering program is to approach its full potential. It will be reached only to the extent that the Government resolves the vexing administrative problems.

The Future

Most new programs are beset with problems during their early life. The contractor value-engineering program is no exception. Its false starts and difficult administrative problems have undoubtedly retarded its growth. Yet, despite the complications, the program is well launched and has a bright future.

This optimistic forecast for the program is shared by top management within DOD.[1] Defense officials see value engineering as one of the best tools available for obtaining true cost savings. Impressed by the success of the DOD in-house program, they are determined to transfer this success to the procurement program.

Defense officials recognize the problems which currently hamper the program and have taken actions to resolve them. Government procurement personnel are being trained in both the

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[1]Kempter Interview, loc. cit.

management and the principles of application of value engineering. Industry is regularly kept abreast of the program through literature, conferences and symposia. Contractor value-engineering efforts are given considerable publicity. Cost-saving results similar to those illustrated in Appendix I are compiled quarterly and widely disseminated. This public recognition is designed to give credit for past accomplishments as well as to stimulate new and wider use of the program.

All this activity focuses on the elimination of real and perceptual roadblocks to a successful value-engineering effort. With the affirmative support of top DOD officials, there is every reason to believe that the program will produce even greater results in the future.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Superior economic strength is vital to the nation's security. This strength depends, in part, upon the efficient allocation of the limited resources at the nation's disposal. Over the years, a variety of programs have been adopted by the Federal Government to promote the efficient allocation and economical use of resources. Of the various programs used by the Government, none have been more comprehensive or as thoroughly organized as the cost-reduction program initiated by the Department of Defense in Fiscal Year 1962.

Cost reduction in defense procurements is a major element of the DOD program. Cost savings have been realized through various mechanisms including increased competition and more extensive use of incentive-type contracts and incentive clauses. The incentives for cost reduction are designed to positively motivate contractors to seek out and eliminate waste and unnecessary costs when performing defense contracts. It has been found that contractors respond most favorably when the cost-reduction incentives appeal to the profit motive. To harness the profit motive, incentives have been developed which offer the contractor greater profits for efficiency and economical performance, and less profit for poor performance.

The objective of cost-reduction and cost-prevention incentives is to obtain more and better defense items at lower costs. Quality, performance, and reliability may not be sacrificed in the interest of economy. To meet this objective, value-engineering incentives have been included in a number of defense contracts.

Value engineering is essentially an organized effort directed toward achieving the required function of an item at the lowest possible cost. Defense hardware items are especially amenable to the value-engineering process because the pressure to develop new and complex items in short time frames often results in unnecessary costs. The value-engineering approach is to identify and eliminate excessive or unnecessary costs, thereby improving value. The end result is an item which can perform the required function at a lower cost.

The use of value-engineering incentives in contracts was prompted in part by the success of the DOD in-house, value-engineering efforts at shipyards, bases, industrial facilities and other Government-owned activities. Organized value-engineering efforts at these activities have produced substantial cost savings as well as significant fringe benefits.

In an effort to transfer this success to the area of defense procurements, value-engineering incentive clauses have been incorporated into the Armed Services Procurement Regulation. The current procurement clauses provide that the Government may either require or merely encourage a defense contractor to perform value-engineering studies. The incentive clauses appeal to

the profit motive by sharing the cost savings with the contractor. The contractor's share of the savings is proportional to the financial risk he assumes in developing cost-reduction proposals. The DOD policy is to be generous with the contractor in sharing the resultant savings.

The contractor value-engineering program has achieved only limited success when compared to the DOD in-house program. It is believed that this limited success is due in part to the newness of the program and the many administrative problems which are inherent in any new program. Inconsistent and improper handling of the contractors' cost-reduction proposals in the early phases of the program, coupled with token-profit incentives, may have given the program a poor image initially.

Officials of the Department of Defense have been quick to recognize the program's shortcomings and have taken positive corrective action. Profit incentives have been strengthened. Administrative procedures have been improved, and a training program on the administration of the value-engineering incentives has been initiated. Once the objectives of the incentives are widely known and the cost-reduction proposals are processed consistently and fairly, it is believed that the defense contractors will look with new interest upon the program's improved profit potential and increase their value-engineering efforts accordingly.

It appears that the Renegotiation Board is more of a perceptual than a real deterrent on the contractor's incentive to conduct a value-engineering program. But it would appear to be in the best interests of the Government for the Renegotiation Board

to establish and publicize its position on excessive profits earned through a value-engineering effort. For this reason, it is recommended that the DOD and other interested Agencies urge the Renegotiation Board to adopt and publish a policy which allows the contractor to retain all excessive profits earned under the value-engineering clauses. This is a reasonable request because the contractor never benefits under these clauses unless the Government also benefits. Excessive profits earned in this manner are a sure indication that the Government has also received significant monetary and fringe benefits.

There are other reasons for the Government to be generous in rewarding contractors for their cost-reduction efforts. Contractors are inclined to put forth greater effort in their work when their past efforts have been properly recognized. But the failure to recognize past superior performance, especially when it has been specifically solicited, usually kills any further motivation to perform well.

The writer doesn't recommend generous rewards for minor efforts. It is merely suggested that contract administrators should consider the overall objectives of the value-engineering program when evaluating the cost-reduction proposals and interpret liberally the DOD's policy to be generous.

This thesis hypothesized that the contractor value-engineering incentive clauses open many new avenues of opportunity for both industry and Government. Industry has the opportunity for vast new profits, and Government has the opportunity to obtain greater quantities of highly reliable goods for

the funds available. Despite the relatively modest results which the program has produced to date, there is every reason to accept this hypothesis without qualification. The environment for cost reduction has never been more favorable within the DOD. The techniques of value engineering are well established and proved effective. The profit incentive offered by the program is real, not token. Defense officials are taking positive steps to reduce or eliminate the significant obstacles which hamper the effectiveness of the program. In short, there is every reason to believe that, when all parties are fully aware of the intent and the potential of the program, value engineering will have a bright and busy future in Government contracts.

APPENDIX I

REPRESENTATIVE VALUE-ENGINEERING

COST-REDUCTION ACTIONS

BY

MAJOR DEFENSE CONTRACTORS

PART ELIMINATION

ELIMINATED

THEN NOW

THIS BURST DIAPHRAGM ASSEMBLY HAD ORIGINALLY BEEN INCORPORATED AS A SAFETY DEVICE ON THE U.S. NAVY MK46 TORPEDO. ANALYSIS OF TEST DATA SHOWED THE EXPECTED HAZARD WAS REDUCED SUFFICIENTLY TO PERMIT ELIMINATION OF THE ASSEMBLY.

COST REDUCTION – $58,793

AEROJET-GENERAL CORPORATION VON KARMAN CENTER

VALUE CONTROL

USE OF NEW MATERIAL IN ELECTRONIC COOLING VALVE

F-111 PROGRAM

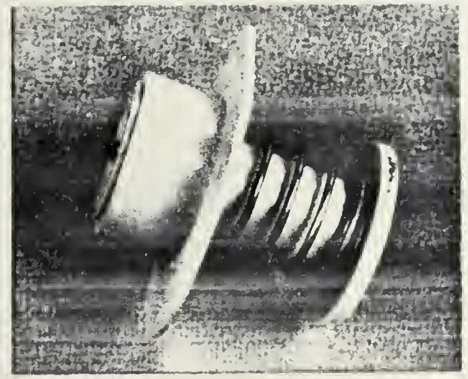
BEFORE

UNIT COST
$ 30 74

- VALVES REQUIRED TO CONTROL COOLING AIR IN ELECTRONIC COMPONENTS WERE MADE OF ALUMINUM ON PAST PROGRAMS.

AFTER

UNIT COST
$ 10 06
(Initial Buy)

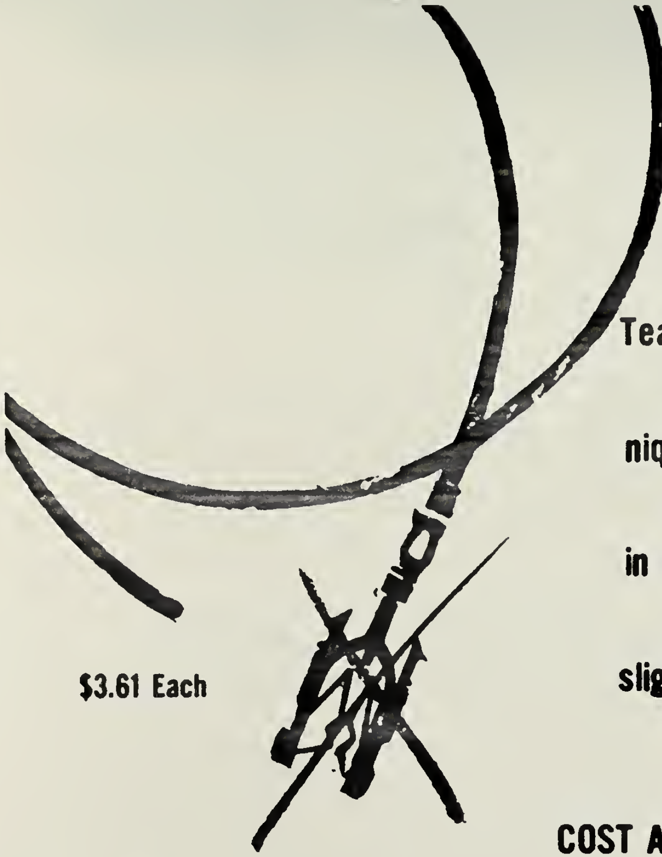


- VE SEMINAR ANALYSIS SHOWED THAT A NEW POLYCARBONATE MATERIAL - LEXAN - WOULD PERFORM FUNCTION AT LOWER COST AND WOULD WEIGH LESS.

$ 221,000.00

(SAVINGS ARE FOR A SERIES OF PARTS CHANGED TO LEXAN)

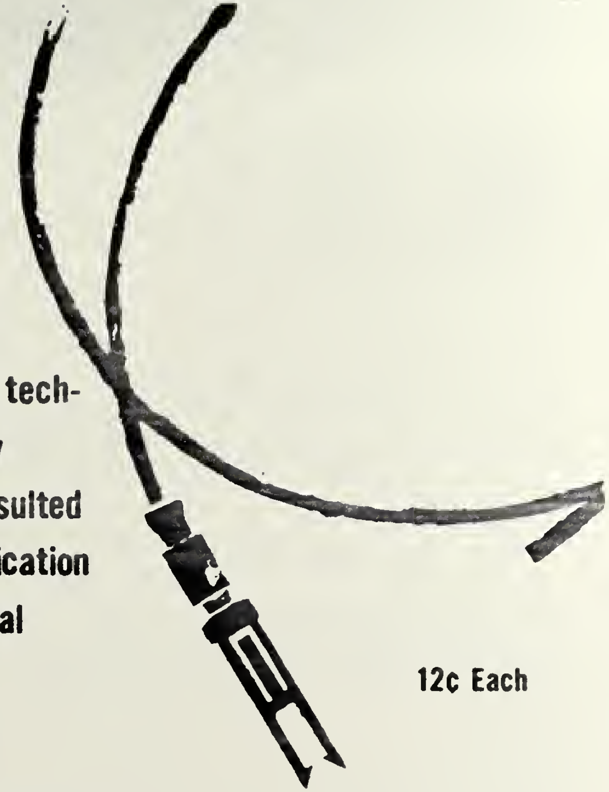
GENERAL DYNAMICS | FORT WORTH



$3.61 Each

VE IN PROCUREMENT/

Teamwork between Engineering and procurement in using Value Engineering techniques resulted in development of a new specification for a terminal which resulted in substantial savings. The new specification is written around an existing terminal slightly modified that performs the same function.



12¢ Each

COST AVOIDANCE · UNIT $3.49 · PERCENTAGE 96.68

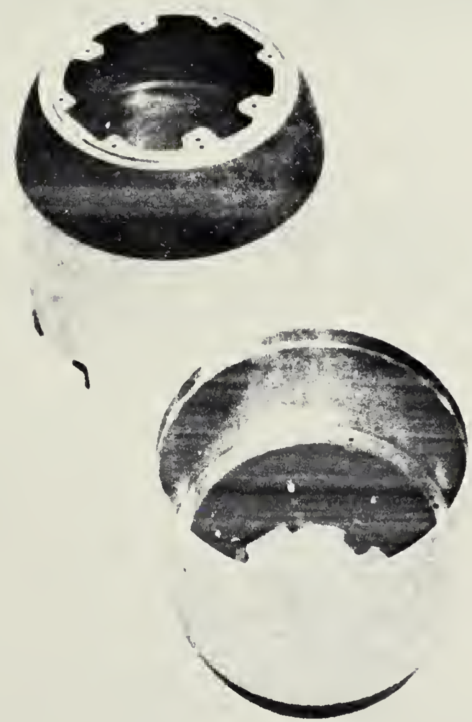
TOTAL SAVINGS $26,663.60

DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION

MK-46 TRANSDUCER & GUIDANCE HOUSING

VALUE ENGINEERING



PRESENT
MANUFACTURING METHOD

CASTING

MACHINED ALUMINUM CASTING WITH CAST SUPPORT RING REQUIRING EXTENSIVE QUALITY CONTROL.

MINIMUM MACHINING

STRENGTH MEETS REQUIREMENTS

UNIT PRICE $346.00

PROPOSED
MANUFACTURING METHOD

FORGING

MACHINED ALUMINUM FORGING WITH MACHINED SUPPORT RING REQUIRING MINIMUM QUALITY CONTROL

REQUIRES ADDITIONAL MACHINING

STRENGTH EXCEEDS REQUIREMENTS

UNIT PRICE $215.00

PROPOSED SAVINGS PER 1000 UNITS $131,000
LESS IMPLEMENTATION COSTS $15,100

PROPOSED NET SAVINGS
PER 1000 UNITS $115,900

Bendix
CORPORATION
PACIFIC DIVISION

VALUE ENGINEERING

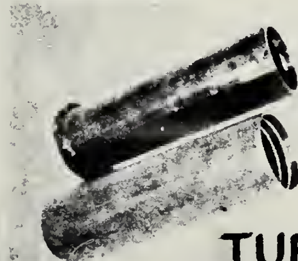
TRANSDUCER REDESIGN FOR COST REDUCTION

AN EXTENSIVE REDESIGN FOR COST REDUCTION OF THE AN/BQQ-1 TRANSDUCER HAS RESULTED IN LARGE SAVINGS TO THE U.S. NAVY. THE CHANGE FROM BRONZE TO STEEL AS THE CHIEF MATERIAL IN THIS UNIT, TOGETHER WITH SIMPLIFICATION OF DESIGN HAS YIELDED A MATERIAL AND LABOR SAVINGS OF $43.69 PER UNIT, WHILE PERFORMANCE AND RELIABILITY REMAIN AS GOOD OR BETTER THAN BEFORE. TYPICAL COMPONENT PIECES, AND THEIR ASSOCIATED SAVINGS ARE SHOWN AT RIGHT:

SINCE APPROXIMATELY 39,000 UNITS ARE INVOLVED, THE TOTAL SAVINGS REPRESENTED BY THIS EFFORT, AFTER REDESIGN AND REQUALIFICATION COSTS ARE DEDUCTED, ADDS UP TO

$ 1,615,000

SUBMARINE SIGNAL DIVISION



	PREVIOUS COST	NEW COST
TRANSDUCER HOUSING	$ 25.82	$ 20.72
END SEAL	$ 15.10	$ 10.55
TUBE	$ 43.79	$ 14.24

APPENDIX II

DEFINITIONS OF TERMS USED IN THE VALUE ENGINEERING GENESIS STUDY

ADVANCES IN TECHNOLOGY: Incorporation of new materials, components, techniques or processes (advances in the state-of-the-art) not available at the time of the previous design effort.

ADDITIONAL DESIGN EFFORT: Application of additional skills, ideas, and information available but not utilized during previous design effort.

CHANGE IN USER'S NEEDS: User's modification or redefinition of mission, function, or application of item (change in user's needs).

FEEDBACK FROM TESTS/USE: Design modification based on feedback from user tests or field experience suggesting that specified parameters governing previous design were unrealistic or exaggerated.

QUESTIONING SPECIFICATIONS: User's specifications were examined, questioned, determined to be inappropriate, out of date, or overspecified.

DESIGN DEFICIENCIES: Design in use prior to VE change proved inadequate in use (e.g., was characterized by inadequate performance, excessive failure rates, or technical deficiencies).

EXCESSIVE COST: Design in use prior to VE change proved technically adequate, but, through use of a cost model or comparative costing techniques, it was determined that the cost of that design was excessive.

APPENDIX III

DEFINITIONS OF FRINGE EFFECTS

RELIABILITY--Ability to meet performance requirements for a determined number of times.

MAINTAINABILITY--Relative ease of repair or replacement.

PRODUCIBILITY--Relative ease of repeatable manufacture.

HUMAN FACTORS--Acceptability of change related to necessary education or dexterity.

PARTS AVAILABILITY--Relative ease in obtaining or manufacturing simplified or standard parts.

PRODUCTION LEAD TIME--Elimination, standardization or simplification of operations or materials.

QUALITY--Characteristics of parts to meet everything specified consistently.

WEIGHT--Lighter in weight.

LOGISTICS--Quantity and complexity of parts needed for field support of end items.

PERFORMANCE--Ability of the change to carry out the intended function at time of initial test or qualification.

PACKAGING--Relative ease of protecting parts until ready for use.

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